

HISTORICAL BACKGROUND ON ORNL PITS AND TRENCHES

ERO11322

[Boegly Draft]

ENVIRONMENTAL RESTORATION
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1. LIQUID WASTE DISPOSAL AT ORNL

1.1. Brief History of Liquid Waste Disposal at ORNL¹

Browder (1959) compiled the first detailed record of radioactive waste disposal operations at the Oak Ridge National Laboratory. The following paragraphs are taken from his report.

"The Laboratory was established in 1943 as a temporary pilot model for the Hanford, Washington works. The Graphite Reactor, a chemical separations plant (the "Hot Pilot Plant"), and a number of large underground concrete (gunitite) tanks were constructed then. The tanks were intended to store all the highly radioactive liquid chemical waste and the liquid uranium waste accumulated during the life of the Laboratory, which was expected to be one year. However, expansion of the scope of the work in 1943 and indefinite continuation of the Laboratory increased the quantities of waste, necessitating a method of disposal to augment storage in tanks. It was decided to precipitate as much of the radioisotopes as possible in the storage tanks and to decant from the tanks those remaining in solution, dilute them with the Laboratory's large volume of process waste water, and disperse them into White Oak Creek. A portion of the precipitated radioisotopes remain as a sludge in the storage tanks at the present time. A dam was built across White Oak Creek 1.7 miles (2.7 Km) below the Laboratory in the autumn of 1943 to create a controlled area for the discharge of radioactive wastes. A settling basin of 1,500,000 gallons (5.7×10^6 L) capacity was completed in July, 1944, to serve as the waste collection and sampling facility and as a stilling pond to permit radioactive solids to settle from the waste before discharge to the creek".

"Additional decontamination of the radioactive supernatant by decay was gained by receiving and holding waste in one of the large storage tanks for as long a time as possible while decanting to the settling basin from another tank containing aged waste. This

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procedure allowed sufficient time for much short-lived (and hence more intense) radioactivity to decay before the waste was discharged to the creek. The isotopes removed by this procedure were 8-day iodine-131, 28-day cerium-141, 33-hour cerium-143, 41-day ruthenium-103, 12.8-day barium-140, and 40-hour lanthanum-140".

"Thus the 7,000 gallons per day (2.6×10^4 L/d) of highest activity waste at ORNL was given a precipitation step, about one month holdup for decay, triple settling (in the tanks, the settling basin, and in the lake behind the dam) and about 500,000 to 1 average dilution in the Clinch River. It was calculated at that time that a maximum 5 curies per day (1.8×10^{10} Bq) of mixed fission products could be discharged safely into the lake, and for several years this criterion was used. An average activity discharge of 284 curies per year (1×10^{13} Bq/yr), considerably below this level, has been maintained to date. This method of disposal by dilution and discharge through a controlled natural drainage basin was continued until June, 1949. This method of disposal had been considered adequate as a temporary measure, but the agreement upon more stringent tolerances necessitated an improvement".

"From June, 1949, until June, 1954, the highly active liquid chemical waste was concentrated by evaporation in a pot-type evaporator instead of being decanted and diluted in the lake. During this period the evaporator processed a total of 11,560,000 gallons (4.4×10^7 L), reducing this volume to 432,000 gallons (1.6×10^6 L) of radioactive concentrate that were stored in the concrete tanks. The water boiled off from this waste contained an average of only 0.014% of the radioactive contamination entering the evaporator. The effectiveness of the evaporator is demonstrated by the fact that during the period of its operation only 14.5 curies per year (54×10^{10} Bq/yr) came from the evaporator, although an average of 320 beta curies per year (1.2×10^{13} Bq/yr) was discharged to the creek from the Laboratory. The remaining contamination came from process waste water and from accidental discharges (mainly leaking waste pipes and valves). The evaporator was taken out of service in June, 1954, after the first 1,000,000-gallon (3.8×10^6 L) experimental ground disposal pit had been in operation for two years. Since that time the pits have received all the highly radioactive liquid chemical waste".

As previously mentioned, this report is concerned only with the LLW that was transferred to the waste pits and trenches during the period 1951-1966. Estimates of the volume of LLW added to the pits and trenches and the period of operation are given in Table 1 (Operations Division Monthly Reports 1951-1966). Because Pits 2, 3, and 4 were operated in series, and further since Pit 4 was installed at a later date than 2 and 3, it is not possible to provide volume and radioactivity totals for each of the pits.

2. Detailed Descriptions of Pits and Trenches

2.1. Waste Pit No. 1 (1951)

According to de Laguna et al. (1958) the first waste pit at ORNL was designed basically as a storage basin for LLW. Pit 1 was located west of SWSA-6 in Melton Valley (see Fig. 1). Struxness (1962) describes the rationale regarding the construction of Pit No. 1 as follows:

"About 10 years ago the Laboratory began to discharge medium-level liquid waste into pits dug into the weathered Conasauga shale. The first pit was thought of as a tank, dug into an impermeable formation, where value could be measured by its volumetric capacity and safety by the inability of the contents to leak out. The first pit did leak, although very slowly, and analysis of the liquid in seeps which formed below the pit showed that the only radionuclide coming through was ruthenium and this only in greatly decreased concentration. The rest of the fission products were adsorbed by the soil and weathered rock".

Waste pit No. 1 was constructed in July 1951. According to Stuxness et al. (1956) the capacity of Pit 1 was 180,000 gal ($xx \times 10^x$ L), and its overall dimensions were 100 by 20 by 15 ft deep. Records of the amount of liquid (and radioactivity) that were added to Pit 1 in 1951 are not detailed, however it appears that about 4.5×10^4 L (12,000 gal) of waste were added prior to deciding that discharges to the pit should be terminated on October 5, 1951. The amount of radioactivity added to Pit 1

has been estimated at 1.5×10^{13} Bq (400 Ci). (NOTE: Struxness et al. (1956) state in Table 1 that 123,000 gallons of waste were added containing 389 beta curies, of which 60 percent were Cs-Ba. I do not know how we resolve the difference in waste volume. They further state an activity level of 1/30 curie per gallon, which would be 4000 curies not 389. Thus it appears that 12,000 gallons may be correct). The waste added to Pit 1 was described as highly alkaline (pH approx. 12.5) with an activity content of about 1/30 curie per gallon, mainly as cesium and ruthenium (60 percent Cs¹³⁷-Ba¹³⁷ and 40 percent Ru¹⁰⁶-Rh¹⁰⁶).

In 19xx Pit 1 was filled with Conasauga shale and capped with an asphaltic concrete cover. Fig. 2 illustrates the current condition of the covered Pit 1.

2.2. Waste Pit No. 2 (1952)

Although Pit 1 leaked it was decided to continue the use of "seepage pits" for the disposal of ORNL's LLW. In 1952, Pit 2 was constructed on a hillock south of Pit 1 (see Fig. 1). The Pit had the shape of a frustrum of an inverted rectangular pyramid, 61 m (210 ft) by 30.5 m (100 ft) in top plan and 4.6 m (15 ft) deep. At a depth of (12 ft) the pit had a volumetric capacity of 3.8×10^6 L (1,000,000 gal). Initially, wastes were transferred to the Pit by tank truck, however in 1954 a pipeline was constructed to handle the waste.

Average daily waste generation during the period Pit 2 was operating by itself was about 26,500 L/d (7,000 gal/d).

2.3. Waste Pit No. 3 (1955)

By 1955 the volume of waste produced was greater than the amount that could be handled by Pit 2 and a new pit having the same dimensions was constructed north of Pit 2 (see Fig. 1). Operation of the pit system, once pit 3 was completed, was as follows: waste was first added to Pit 3 and the overflow was directed to Pit 2. Due to this operating method,

estimates of the amount of waste handled by each pit cannot be estimated, however Lomenick et al. (1967) state that Pits 2 and 3 contain essentially all of the Sr^{90} and about 85% of the Cs^{137} discharged to the system.

In addition to the liquid LLW, large quantities of sludge from the ORNL low-level radioactive Waste Water Treatment Plant have been dumped into Pit 3, although smaller amounts were placed in Pits 2 and 4 (Lomenick et al. 1967). This sludge, which consisted principally of illitic clay and calcium carbonate, accumulated at the rate of several thousand gallons per week at the treatment plant. It contained relatively little activity prior to being dumped into the pits; however, upon contact with the relatively high activity pit water the sludge sorbed a large part of the cesium and strontium in the pits.

Pits 2 and 3 were backfilled and mounded with weathered conasauga shale in 1962. Pit 3 was subsequently capped with a 1-in. thick asphaltic-concrete surface (Lomenick et al 1967).

2.4. Waste Pit No. 4 (1956)

Waste volumes continued to increase and it was decided to construct another pit in 1956. Pit 4 had the same dimensions and volumetric capacity as Pits 2 and 3. It was located south of Pit 2. Once Pit 4 was in operation waste continued to be added to Pit 2 first; with overflow from Pit 2 directed to Pit 3, and any overflow from Pit 3 being transferred to Pit 4. Thus, Pit 4 did not necessarily receive waste additions each time new waste was added to the three-pit system. It was estimated that about 40,000 gal per week of waste was added to the Pit system during the period that Pits 2, 3, and 4 were in use (Lomenick et al. 1967).

2.5. Waste Trench No. 5 (1960)

de Laguna et al. (1958) described the location and design of the first of ORNL's waste trenches. The site selected had a depth to groundwater of 13 m (40 ft) and the pit was to be oriented at right angles to the strike to intercept the maximum number of bedding planes. The trench was described as about 300 ft (91 m) long, 25 ft (7.6 m) wide at the top and

about 15 ft (4.6 m) deep. The sides were sloped so that the width at the bottom was negligible since previous pit studies has shown that most of the leakage would occur through the sides. Since storage volume was not a major consideration in seepage pit design, the pit was to be filled with coarse crushed rock and a mound of dirt compacted over the trench. This was done to minimize the effects of rainfall and evaporation; it also reduced the potential danger of airborne contamination and minimized radiation exposures to personnel working near the trench. Trench 5 began operation in 1960 and it is estimated that more than 30×10^6 L (7.9×10^6 gal) of LLW and 0.3×10^6 Ci (approximately 107 GBq) of activity were added to the trench before it was covered with an additional mound of Conasauga shale and capped with an asphaltic-concrete surface in 1966 (Duguid et al. 1977). Although Trench 5 operated satisfactorily, it could handle only about one-half of the ORNL-generated LLW. During the operation of Trench 5 the water table under the trench rose from 3 to 5 m (10 to 16 ft) but still remained below the level of the trench bottom.

2.6. Waste Trench No. 6 (1961)

Construction of Trench 6 was completed in 1961, and the first waste added on September 10, 1961 (Kertesz 1961). On October 5, 1961 sampling revealed the presence of strontium in a seep below the trench. This was the first reported leak of strontium from any of the ORNL pits and trenches. The seep was reported to be about 100 yards below the trench and the seepage rate was about 0.15 gal/min (Kertesz 1961). Further discharges of waste to Trench 6 were stopped, and Pits 2, 3, and 4 were put back into service.

A review of the problems related to Trench 6 by the ORNL Waste Effluents Committee (Kertesz 1961) indicated that the site chosen was not one that had been earlier selected as potential sites for new trenches, and that little or no exploratory drilling had been undertaken to investigate groundwater elevations and their fluctuations with time. These factors, combined with changes in the pH and composition of the

waste added to the trench, were cited as possible reasons for the failure of the trench to retain strontium. It was suggested at the committee meeting that a new trench be installed rather than perform the remedial actions felt necessary to continue operation of Trench 6.

2.7. Waste Trench No. 7 (1962)

Initially, ILW Trench 7 was designed to be a composite of three trench sections, each 30.5 m (100 ft) long, 4.6 m (15 ft) deep, 1.2 m (4 ft) wide at the bottom, and 4.6 m (15 ft) wide at the top. A test hole was drilled in the fall of 1961 so that the groundwater level at the proposed site could be measured. The hole was located near what was planned to be the middle of the trench. The water level in this hole was 236.2 m (775 ft), or about 10 m (30 ft) below the ground surface as of December 4, 1961. On February 26, 1962, the water level in the well rose about 4.5 m (15 ft) to an elevation of 240.7 m (790 ft), which was about the proposed elevation of the trench bottom. A second test well was drilled in May 1962 about 30.5 m (100 ft) north of the first well. The water level in this well was 242.6 m (796 ft) which was a few meters above the proposed trench bottom. As a result the upper trench section was not constructed. Elimination of the third trench section (Trench 7c) reduced the disposal capacity by about half, however it minimized the possibility of groundwater entering the trench due to seasonal increases in the water table elevation. The design criteria for ILW Trench 7 are illustrated in Fig. X, which shows the approximate location of the water table in August 1981. Trench 7 received wastes from October 1962 until April 1966, after which time hydrofracture was used for LLW disposal at ORNL.

2.8. Hydraulic Fracturing (Hydrofracture)

Starting in 1959, studies were initiated on the potential use of an oil field technique called hydraulic fracturing (or hydrofracture) as a possible method for disposal of LLW (de laguna et al. 1968). Using this technique LLW mixed with solids is injected into a preformed fracture in an impermeable rock formation at depth. After the slurry is injected, the

mixture hardens encapsulating the radionuclides in an insoluble matrix. Using this technique multiple fractures can be formed in the formation allowing additional waste slurry to be injected at a later date. Because the fractures are formed at depth (xxx to xxx m for the new ORNL Hydrofracturing facility), concern with contamination of groundwater is minimized. Since 1966 all of ORNL's LLW has been disposed using the hydraulic fracturing technique.

Table 2. General Information on LLW disposal operations at ORNL

Date	Volume	Event
1951	0.012 x 10 ⁶	Waste Pit No. 1
1952-62		Waste Pit No. 2
1955-62	24.0 x 10 ⁶	Waste Pit No. 3
1956-76		Waste Pit No. 4
1960	9.5 x 10 ⁶	Trench 5
1961	0.13 x 10 ⁶	Trench 6
1962-64	4.5 x 10 ⁶	Trench 7a
1962-64	4.0 x 10 ⁶	Trench 7b
1964-Present	---	Hydrofracture

Table 3. LLW discharged to chemical waste pits

Pit or Trench	Volume (gal)	Activity (Ci)			
		Total	Sr-90	Cs-137	Ru-106
1	0.012×10^6	400	---	---	---
2,3,4(1)	24.0×10^6		43,500	201,000	236,000
5	9.5×10^6		96,500	207,000	5,000
6	0.13×10^6		125	660	50
7a	4.5×10^6		24,400	117,000	1,750
7b	4.0×10^6		23,500	102,000	1,480
Totals	42.1×10^6		<u>188,000</u>	<u>628,000</u>	<u>244,000</u>

NOTE: Lomenick et al. (1967) say "about 21 million gallons (over 1/2 million Ci)" to pits 2, 3, and 4. How can we resolve this?

X. REFERENCES

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Fig 1. (ORNL DWG 74-9604

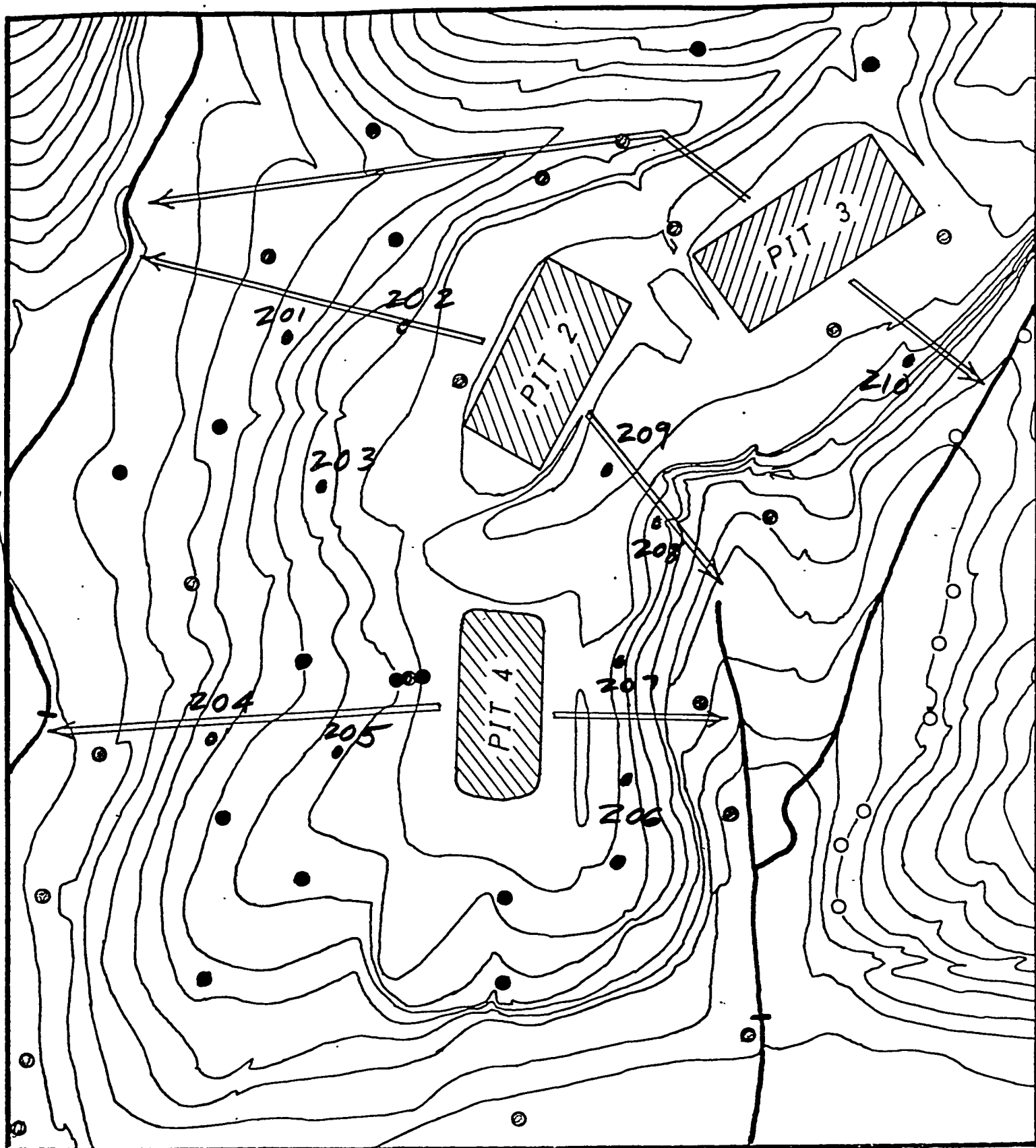
Fig 2. (ORNL Photo xxxxxx)

Fig. 3. (ORNL Photo

A topographic map showing a chemical waste site. The map features contour lines with elevations of 800, 825, 850, and 875. A road is labeled "ROAD" at the top left. A "CHEMICAL WASTE PIT NO 1" is marked with a black dot and an arrow pointing to a rectangular area. Elevation points are marked with circles and numbers: 1790, 181, 182, 183, 185A, 183B, 875, 865, and 850. The map also shows a dashed line representing a boundary or road.

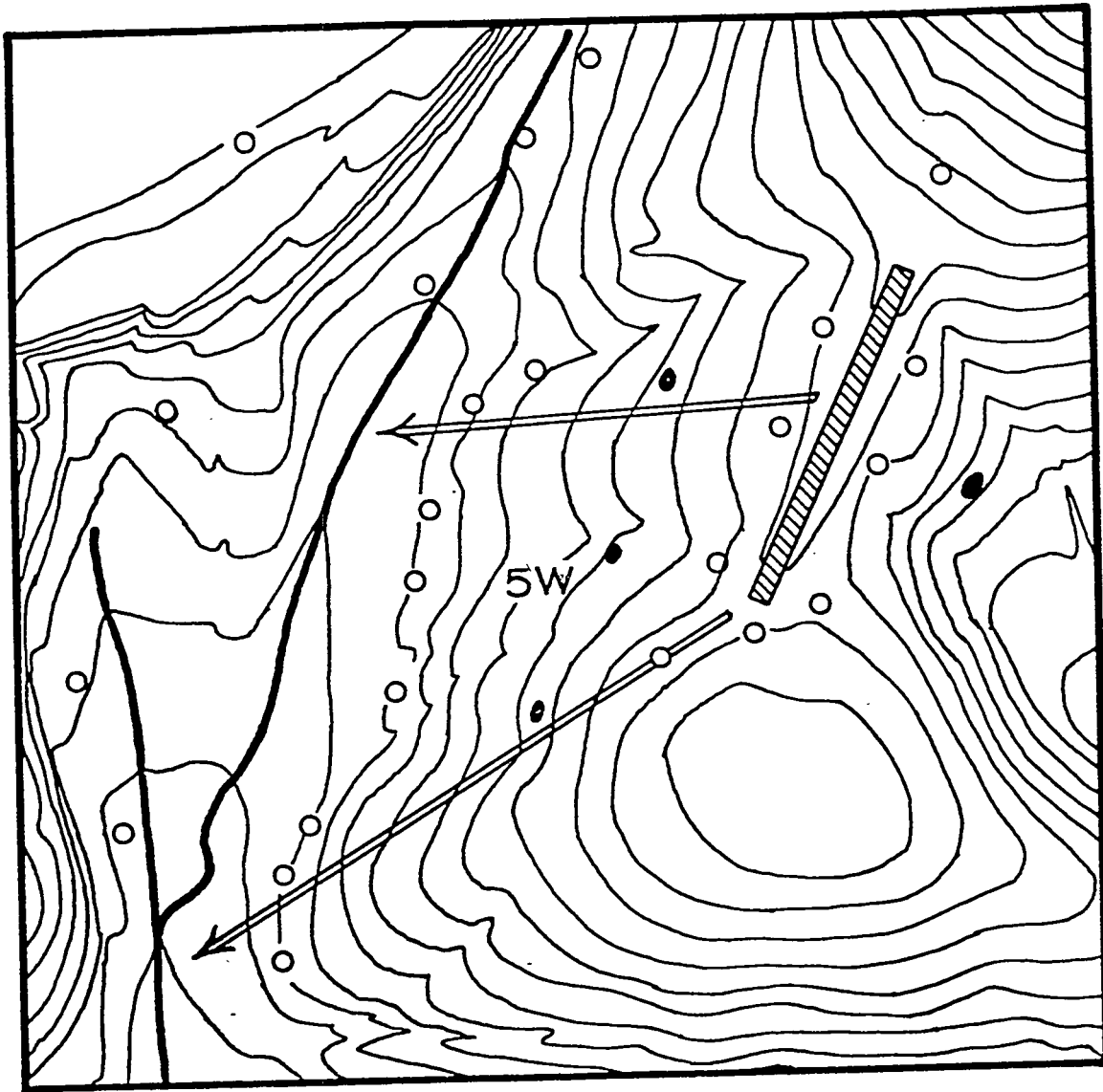
500'

- deep well > 70 (existing)
- shallow



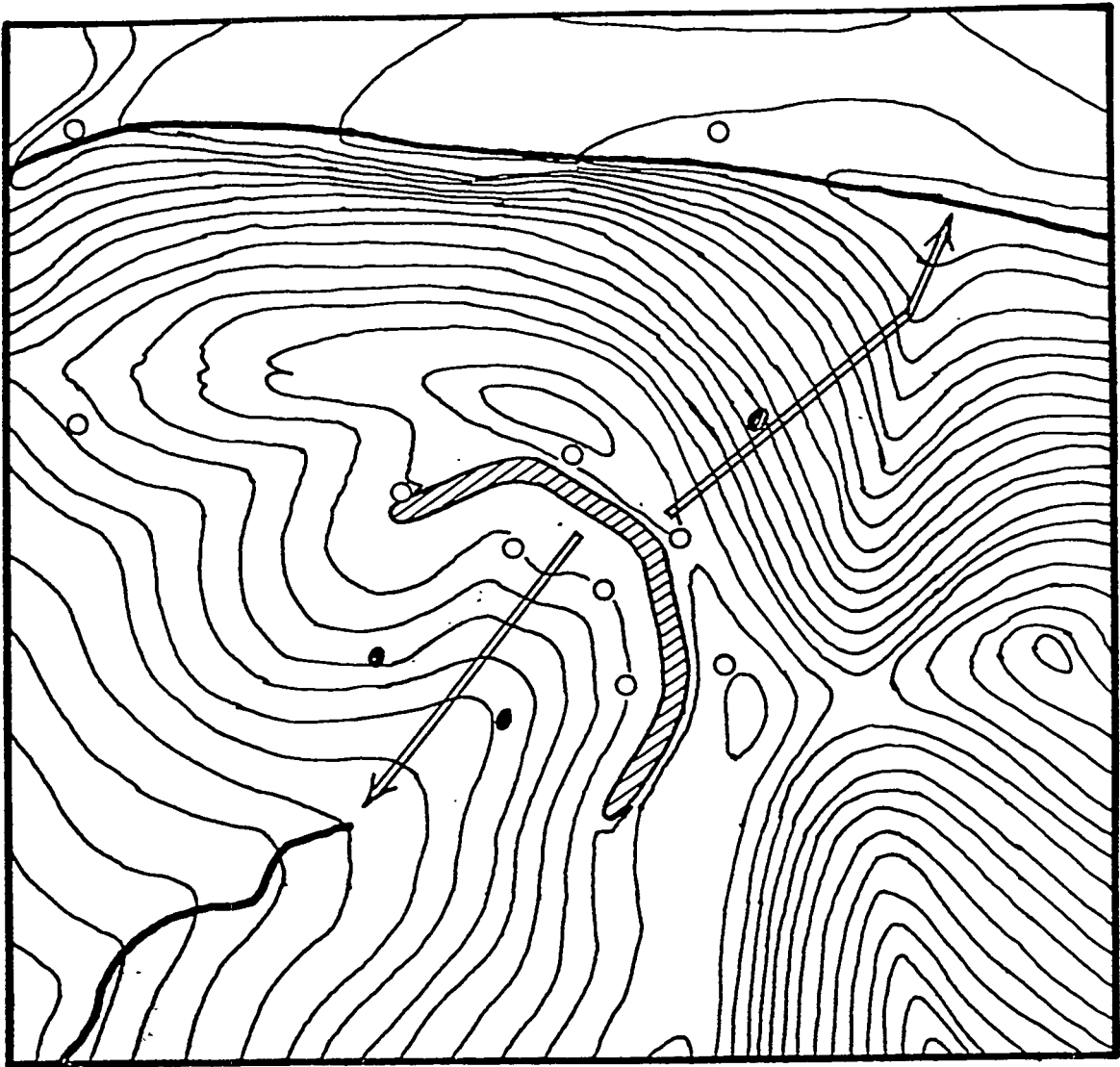
SEE PAGE PITS 2, 3, and 4

500'



SEEPAGE TRENCH 5

← 500' →



SEEPAGE TRENCH 6

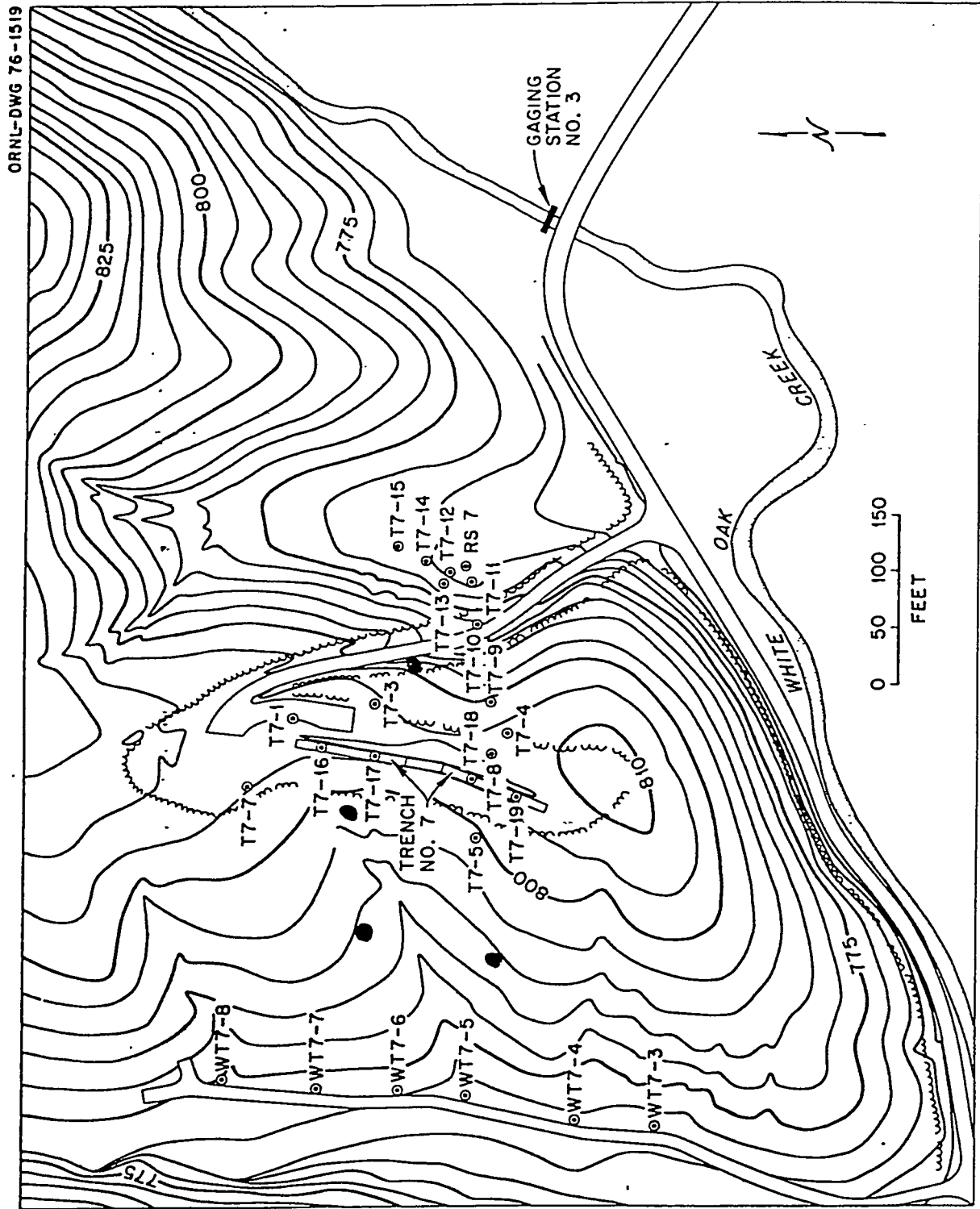


Fig. 2. Location of wells near trench 7.

SOLID WASTE MANAGEMENT SITES AT ORNL

Waste Area Grouping - Site Description (ORNL Building Directory Number)

7.0 LLW Pits and Trenches Area (Spalding)

- 7.1 Decontamination Facility (7819)
- 7.2 Homogeneous Reactor Experiment (HRE) Fuel Wells (7809)
- 7.3 Hydrofracture Experimental Site 1, Soil Contamination (HF-S1A)
- 7.4a,b,c LLW Lines and Leak Sites - Pits and Trenches Area (3 sites)
 - a = Hydrofracture No. 1 - Release of Grout
 - b = Pit 6 - Southeast
 - c = End of Trench 7 Access Road
- 7.5 Pit 1 (7805)
- 7.6 Pits 2, 3 and 4 (7806, 7807, 7808)
 - a = 7806
 - b = 7807
 - c = 7808
- 7.7 Trench 5 (7809)
- 7.8 Trench 6 (7810)
- 7.9 Trench 7 (7818)
- 7.10 Shielded Transfer Tanks (ST1, ST2, ST3, ST4, ST5)
 - a = ST1
 - b = ST2
 - c = ST3
 - d = ST4
 - e = ST5

PERFORMANCE ASSESSMENT/SITE INVESTIGATION REPORT

Waste Area Group Name: LLW Pits and Trenches Area
Waste Management Unit Name: Decontamination Facility (7819)

WAG Identification Number

7.0

WAG Name

LLW Pits and Trenches Area

SWMU Identification Number

7.1

SWMU Name

Decontamination Facility (7819)

Location of Unit

The ORNL Decontamination Facility (7819) is located north of Lagoon Road near the entrance to SWSA 4. See grid coordinates XXX and YXX in Fig. X.

General Dimensions and Capacities

The building is divided into two sections, a Contaminated Zone containing two open pits for acid baths and a clean area. Additional decontamination activities were conducted in the back of the building.

Function of the Unit

The facility was used to decontaminate such items as isotope carriers from laboratories and hot cells by means of acid baths and sand blasting.

Dates of Operation

Site commissioned: early 1960s

Site decommissioned: late 1970s

Waste Characterization

The contamination consists of the building, equipment, and the land area within a 15-m (49.2-ft) radius of the building. In a radiological characterization survey, the radiation exposure rate (beta and alpha) ranged from a maximum of 3.5 R/h (equipment and

shelves) in the zone for acid baths to < 10 mR/h at floor level in the clean area. Wet towel smears indicated the transferable radioactivities (beta and alpha) at the same locations to be much lower (e.g., < 10 mR/h) over bath zone equipment and shelves, and < 1 mR/h clean area floor level. The uncovered sand used in blast cleaning is located about 12 m (39 ft) from the building and has a maximum exposure rate of 2 mR/h.

Release Data

See above.

PERFORMANCE ASSESSMENT/SITE INVESTIGATION REPORT

Waste Area Group Name: LLW Pits and Trenches Area
Waste Management Unit Name: Homogeneous Reactor Experiment (HRE),
Fuel Wells, 7809

WAG Identification Number

1.0

WAG Name

LLW Pits and Trenches Area

SWMU Identification Number

7.2

SWMU Name

Homogeneous Reactor Experiment (HRE) Fuel Wells (7809)

Location of Unit

(Located just south of Trench #5 (Latitude 35.90950, Longitude 84.32054).

General Dimensions and Capacities

Seven auger holes (S1-S7) 0.3 m (1.0 ft.) in diameter by 5.2 (17.0 ft) deep. The holes are about 3 m (10 ft) apart. The auger holes received about 510 L (135 gal) of liquid waste.

Function of the Unit

The site was designed to hold residual fuel solution from the Homogenous Reactor that was stored in the Homogenous Reactor Chemical Plant decay tanks.

Dates of Operation

Site commissioned: 1964

Site decommissioned: 1964

Waste Characterization

The fuel wells contain 510 L (135 gal) of 4 molar sulfuric acid solution containing 4,652 g (about 10 lb) of uranium and fission products, Sr-90, and Ru-106. After disposal of the wastes, each well was filled to ground level with soil and marked with a brass plaque

bearing well coordinates, liters of waste disposed, and grams of U-235 contained in the solution.

U-235 Data

U-235 content of the wells is S1, 319 g; S2, 528 g; S3, 704 g; S4, 704 g; S5, 717 g; S6, 730 g; S7, 260 g.

PERFORMANCE ASSESSMENT/SITE INVESTIGATION REPORT

Waste Area Group Name LLW Pits and Trenches Area
Waste Management Unit Name Hydrofracture Experimental Site 1, Soil
Contamination (HF-S1A)

WAG Identification Number

1.0

WAG Name

51

LLW Pits and Trenches Area

SWMU Identification Number

7.3

SWMU Name

Hydrofracture Experimental Site 1, Soil Contamination (HF-S1A)

Location of Unit

No Information

General Dimensions and Capacities

No Information

Function of the Unit

No Information

Dates of Operation

No Information

Waste Characterization

No Information

Release Data

No Information

PERFORMANCE ASSESSMENT/SITE INVESTIGATION REPORT

Waste Area Group Name: LLW Pits and Trenches Area
Waste Management Unit Name: LLW Lines and Leak Sites - Pits and
Trenches Area Site 1)

WAG Identification Number

7.0

WAG Name

LLW Pits and Trenches Area

SWMU Identification Number

7.4a

SWMU Name

LLW Lines and Leak Sites - Pits and Trenches Area (Site 1)

Location of Unit

(No Information

General Dimensions and Capacities

No Information

Function of the Unit

No Information

Dates of Operation

No Information

Waste Characterization

No Information

Release Data

No Information

PERFORMANCE ASSESSMENT/SITE INVESTIGATION REPORT

Waste Area Group Name LLW Pits and Trenches Area
Waste Management Unit Name LLW Lines and Leak Sites - Pits and
Trenches Area (Site 2)

WAG Identification Number

7.0

WAG Name

LLW Pits and Trenches Area

SWMU Identification Number

7.4b

SWMU Name

LLW Lines and Leak Sites - Pits and Trenches Area (Site 2)

Location of Unit

(No Information

General Dimensions and Capacities

No Information

Function of the Unit

No Information

Dates of Operation

No Information

Waste Characterization

No Information

Release Data

No Information

PERFORMANCE ASSESSMENT/SITE INVESTIGATION REPORT

Waste Area Group Name: LLW Pits and Trenches Area
Waste Management Unit Name: LLW Lines and Leak Sites - Pits and
Trenches Area, Site 3

WAG Identification Number

7.0

WAG Name

LLW Pits and Trenches Area

SWMU Identification Number

7.4c

SWMU Name

LLW Lines and Leak Sites - Pits and Trenches Area (Site 3)

Location of Unit

No Information

General Dimensions and Capacities

No Information

Function of the Unit

No Information

Dates of Operation

No Information

Waste Characterization

No Information

Release Data

No Information

PERFORMANCE ASSESSMENT/SITE INVESTIGATION REPORT

Waste Area Group Name: LLW Pit and Trenches Area
Solid Waste Management Unit Name: Pit 1 (7805)

WAG Identification Number

7.0

WAG Name

LLW Pits and Trenches Area

SWMU Identification Number

7.5

SWMU Name

Pit 1 (7805)

Location of Unit

Pit 1 is located just west of SWSA 4 in Melton Valley. See grid coordinates XXX and XXX in Fig. X.

General Dimensions and Capacities

The pit is 30 m (98 ft) long by 6 m (20 ft) wide. The capacity of Pit 1 is estimated to be >465,500 L (122,971 gal) of liquid waste.

Function of the Unit

The purpose of the pit ^{was} ~~is~~ to hold concentrated liquid waste, ^{however}

Date of Operation

The pit received 465,555 L (122,985 gal) of concentrated liquid waste between July 1951 and October 1951. It received additional discharges from the decontamination building 7819 between 1962 and 1964.

Waste Characterization

The first wastes the pit received, in 1951, were very alkaline (pH 12.5) and contained Cs-137, Ru-106, U, and Pu. The estimated radionuclide activities for Cs-137 and Ru-106 in Ci are 233 and 156, respectively. In addition, it is estimated that 196 kg of U and 266 mg of Pu were discharged into the pit. The nature of the waste that was discharged into the pit between 1962 and 1964 is unknown; the total activity was probably small.

Discharges to the pit were H₂ and CH₄ and were measured. The gas contained 4 percent H₂ and

PERFORMANCE ASSESSMENT/SITE INVESTIGATION REPORT

Waste Area Group Name LLW Pit and Trench Area
Solid Waste Management Unit Name Pit 1

WAG Identification Number

7.0

WAG Name

LLW Pits and Trenches Area

SWMU Identification Number

7.6a

SWMU Name

Pit 2 (7806)

Location of Unit

See grid coordinates XXX and XXX in Fig. X. Pit 2 is located just southwest of Pit 1.

General Dimensions and Capacities

Pit 2 is 61 m (200 ft) long and 6 m (20 ft) wide. Pits 2, 3, and 4 have received an estimated 79,500,000 L (21,001,515 gal) of liquid waste.

Function of the Unit

Signature of
The pit was built to ~~store~~ liquid waste.

Dates of Operation

Site commissioned: 1952

Site decommissioned: 1962

Waste Characterization

Between 1952 and 1954 the pit received 4,900,000 L (1,294,433 gal) of concentrated liquid waste containing 16,600 Ci of beta activity. After 1955, Pit 2 received overflow through pipes from Pit 3. For this reason it is not possible to determine the amounts of radioactivity it received after 1955. In 1957 sludge from the older process waste treatment plant was also disposed of in the pit. The amount of radioactivity the pit received from the sludge was relatively small. Between 1959 and 1961 pits 2, 3, and 4 received large

Need general note to reflect that Pits 2, 3, and 4 were interconnected and the activity and volume data is on all three pits and cannot be separated!

discharges of Ru-106, but because of the interconnecting overflow pipes between the pits it is impossible to determine the amount of activity Pit 2 received. It is estimated that pits 2, 3, and 4 together are contaminated with Cs-137, Ru-106, Sr 90, and trivalent rare earths (TREs) having activities of 184,000 Ci, 230,000 Ci, 42,000 Ci; and 70,000 Ci, respectively.

Release Data

See above.

PERFORMANCE ASSESSMENT/SITE INVESTIGATION REPORT

Waste Area Group Name: LLW Pits and Trenches Area
Solid Waste Management Unit Name: Pit 3 (7807)

WAG Identification Number

7.0

WAG Name

LLW Pits and Trenches Area

SWMU Identification Number

7.6b

SWMU Name

Pit 3 (7807)

Location of Unit

See grid coordinates XXX and XXX in Fig. X. Pit 3 is located just northeast of Pit 2.

General Dimensions and Capacities

Pit 2 is 61 m (200 ft) long and 6 m (20 ft) wide. Pits 2, 3, and 4 have received an estimated 79,500,000 L (21,001,515 gal) of liquid waste.

Function of the Unit

The pit was built to ^{store}~~store~~ liquid waste.

Dates of Operation

Site commissioned: 1955

Site stopped operating: 1961

The site was backfilled and covered with asphalt in 1963.

Waste Characterization

Because of the interconnecting overflow pipes between pits 2, 3, and 4 it is impossible to determine the amount of activity Pit 3 received. Pits 2 and 3 together probably contain most of the Sr-90 and Cs-137 discharged to all the pits. It is estimated that pits 2, 3, and 4 together are contaminated with Cs-137, Ru-106, Sr-90, and trivalent rare earths (TREs) having activities of 184,000 Ci; 230,000 Ci; 42,000 Ci; and 70,000 Ci, respectively.

Release Data

See above

PERFORMANCE ASSESSMENT/SITE INVESTIGATION REPORT

Waste Area Group Name: LLW Pits and Trenches Area
Solid Waste Management Unit Name: Pit 4 (7808)

WAG Identification Number

7.0

WAG Name

LLW Pits and Trenches Area

SWMU Identification Number

7.6c

SWMU Name

Pit 4 (7808)

Location of Unit

See grid coordinates XXX and XXX in Fig. X. Pit 4 is located just downhill and south from pit 2.

General Dimensions and Capacities

Pit 4 is 61 m (200 ft) long and 6 m (20 ft) wide. Pits 2, 3, and 4 have received an estimated 79,500,000 L (21,001,67 gal) of liquid waste.

Function of the Unit

The pit was built to ~~store~~ ^{store} liquid waste.

Dates of Operation

Pit 4 began to receive overflow from pit 2 in 1956. It was back-filled in 1976 and paved with asphalt in 1980.

Waste Characterization

Because of the interconnecting overflow pipes between the pits it is impossible to determine the amount of activity pit 2 received. It is estimated that pits 2, 3, and 4 together are contaminated with Cs-137, Ru-106, Sr-90, and trivalent rare earths (TREs) having activities of 184,000 Ci; 230,000 Ci; 42,000 Ci; and 70,000 Ci, respectively.

Release Data

The pit did have leakage problems. In 1959 and 1961 interceptor trenches were dug and the liquid was pumped back to the pit.

PERFORMANCE ASSESSMENT/SITE INVESTIGATION REPORT

Waste Area Group Name: LLW Pits and Trenches Area
Solid Waste Management Unit Name: Trench 5 (7809)

WAG Identification Number

7.0

WAG Name

.fi

LLW Pits and Trenches Area

SWMU Identification Number

7.7

SWMU Name

Trench 5 (7809)

Location of Unit

See grid coordinates XXX and XXX in Fig. X. Trench 5 is located on a ridgetop perpendicular to strike just east of pits 2, 3, and 4.

General Dimensions and Capacities

Trench 5 is 93 m long by 1 m wide. It has received an estimated 36,000,000 L of waste.

Function of the Unit

Built to receive liquid waste.

Dates of Operation

The trench was constructed in 1960 and paved with asphalt in 1970.

Waste Characterization

Trench 5 has received Cs-137, Ru-106; Sr-89,90 and Co-60 with radionuclide activities of 205,600 Ci; 6,385 Ci; 96,750 Ci and 3,045 Ci respectively. Between 1960 and 1966 the trench received about 15,000 L per day of liquid waste.

Release Data

Very little visual ~~data~~ leakage has been observed from this trench.

PERFORMANCE ASSESSMENT/SITE INVESTIGATION REPORT

Waste Area Group Name: LLW Pits and Trenches Area
Solid Waste Management Unit Name: Trench 6 (7810)

WAG Identification Number

7.0

WAG Name

~~Fig.~~

LLW Pits and Trenches Area

SWMU Identification Number

7.8

SWMU Name

Trench 6 (7810)

Location of Unit

(See grid coordinates XXX and XXX in Fig. X. Trench 6 is located on a ridgetop just south of SWSA 4.

General Dimensions and Capacities

Trench 6 is 154 m. long by 1 m wide. It has received an estimated 681,000 L of liquid waste.

Function of the Unit

Built to receive liquid waste.

Dates of Operation

~~Trench 6 was constructed in 1961.~~ Due to severe leakage problems it was used for only about 1 month. It was paved with asphalt in 1981.

Waste Characterization

Trench 5 has received Cs-137, Ru-106, Sr-90 and Co-60, with radionuclide activities of 665 Ci, 501 Ci, 145 Ci and 24 Ci, respectively.

Release Data

The trench had severe Sr-90 and Cs-137 leakage problems when it was first put into service. Due to this problem it was only used about 1 month.

PERFORMANCE ASSESSMENT/SITE INVESTIGATION REPORT

Waste Area Group Name: LLW Pits and Trenches Area

Solid Waste Management Unit Name: Trench 7 (7818)

WAG Identification Number

7.0

WAG Name

~~LLW Pits and Trenches Area~~

LLW Pits and Trenches Area

SWMU Identification Number

7.9

SWMU Name

Trench 7 (7818)

Location of Unit

(See grid coordinates XXX and XXX in Fig. X. Trench 7 is located east of trench 5.

General Dimensions and Capacities

Trench 7 is 60 m long by 1 m wide. It has received an estimated 36,000,000 L of liquid waste.

Function of the Unit

Built to receive liquid waste.

Dates of Operation

Trench 7 was built in 1962. It was used until 1966 and paved with asphalt in 1970.

Waste Characterization

Trench 5 has received Cs-137, Ru-106, Sr-90 and Co-60 with radionuclide activities of 231,000 Ci; 3,400 Ci; 48,000 Ci and 1,500 Ci respectively.

Release Data

No Information

PERFORMANCE ASSESSMENT/SITE INVESTIGATION REPORT

Waste Area Group Name: LLW pits and Trenches Area
Solid Waste Management Unit Name: Shielded Transfer Tanks (ST1, ST2, ST3, ST4, ST5)

WAG Identification Number

7.0

WAG Name

~~LLW~~

LLW pits and Trenches Area

SWMU Identification Number

7.10

SWMU Name

Shielded Transfer Tanks (ST1, ST2, ST3, ST4, ST5)

Location of Unit

See grid coordinates XXX and XXX in Fig. X. These tanks consist of four Model II tanks designated as RD-C-43, RD-C-44, RD-C-47, RD-C-48, and one Model III tank referred to as the Gun Barrel Tank. Tanks RD-C-43, RD-C-47, RD-C-48, and the Model III tank are located in a fenced storage yard on the west end of Solid Waste Storage Area (SWSA) No. 4. Tank RD-C-44 is located behind Building 7819 along Lagoon Road at the turnoff to SWSA No. 4, in an unfenced area with no access control.

General Dimensions and Capacities

The Model II tanks consist of a 1,900-L, 1.0 cm thick stainless-steel liner surrounded with 8.9 cm of lead shielding which is encased in a 1.9-cm steel outer shell. The vessels contain approximately 1,500 L of Decalco inorganic ion exchange media. Tank RD-C-44 is reported to be empty. The Model III tank consists of a 750 L stainless-steel liner encased in 23 cm of steel. The vessel contains approximately 560 L of AW-500 inorganic ion exchange media.

Function of the Unit

These tanks were used to ship Cs-137-loaded ion exchange resins to ORNL from Richland, Washington.

Dates of Operation

The tanks were used during the 1960's.

Waste Characterization

The tanks are contaminated with Cs-137. Results from a Beta/Gamma Probe for tanks RD-C-43, RD-C-44, RD-C-47, RD-C-48, and the Gun Barrel Tank gave readings of 2-3 mrad/h, 3-5 mrad/h, 2-3 mrad/h, spots of 10-20 mrad/h, and 2 mrad/h, respectively. Tank RD-C-44 had one spot that gave a reading of 20 mrad/h.

Release Data

There is no direct evidence of any leakage.

Site Characterization

The pits' and trenches' area is one of the most well studied sites on the Oak Ridge Reservation in terms of its geologic and hydrologic characteristics. In geology, the studies of deLaguna et al (1958) produced some of the most definitive relationships between geologic structure and seepage patterns (drawings 28158 and 28384R). deLaguna (1962) also did extensive coring and augering around pits 2 and 4 showing that particular bedding planes conducted most of the pits' seepage (drawings 62143-62148). This type of geologic input led to the improved design of trenches 5 and 7 which were oriented perpendicular to geologic strike. These geologic studies have probably told as much as can be learned in this complicated sedimentary formation, the Conasauga. More recent studies in adjoining areas (Davis et al 1984, in SWSA 6; and Rothschild et al 1984, in the proposed SWSA 7 site) have added some details. The details of the geologic column of the Conasauga Group formation have been extended further (drawings 83-13887R2 and 82-13318) than what was available in 1958 (drawings 6631 and 28383). Two pictures summarize excellently how complicated is the secondary folding and faulting of the stratigraphic column in the area of the pits' and trenches: PHOTO-15654 of the southern portion of the east wall of pit 4 and drawing 81-215738 of the stratigraphic exposure along a roadcut on the eastern side of trench 7. This structure is so complicated on the scale of the pits and trenches that it has generally been concluded that the identification of precise flowpaths for seepage from the pits and trenches may be close to impossible or economically prohibitive using conventional coring and augering in these areas (deLaguna et al 1958; Olsen et al 1983). Clearly the work of Olsen et al (1983) has demonstrated that discrete fractures, conduits, or strata carried most of the seepage radioactivity (drawings 83-1555 and 83-1556). But without much more extensive coring or augering with borehole-logging, the assurance that all conducting structures have been identified cannot be guaranteed. If a complete picture of these conducting strata or features could be attained, then a monitoring system for the area could be recommended with confidence and accurate fracture-flow groundwater models of each trench could be produced to describe site performance. More pragmatically, such detailed knowledge of the spatial distribution of residual activity in and around the pits and trenches would put the planning of corrective actions on an accurate basis; areas needing the protection of engineered barriers could be accurately planned.

Such detailed knowledge of the spatial distribution of radioactivity in, around, and under each pit and trench might be obtained without the large expense and site disruption associated with coring, augering, and sample retrieval for expensive radiochemical analyses. The

gross-beta and gamma activity of soil profiles could well be obtained in situ by placing a GM tube detector in the ground. This technique has been used to log boreholes which were previously constructed by augering or coring (Olsen et al. 1983; Struxness and Morton 1956). A recent demonstration of grout-injection machinery at ORNL clearly showed that 1-inch diameter pipe, fitted with a well point to form a lance, could be inserted into the soil formation by a hydraulic driver using track guides. If the well point were fitted with an adapted GM-type detector, depth increments of the soil formation could be logged without previous augering or coring. Measurements could be taken in the field either during insertion or, more likely, on withdrawal of the lance. Insertions to depths of 20 feet could be performed in a few minutes so that borehole logging times would be determined by the radioactivity detection sensitivity desired; many depth logs could in theory be produced in one day. With such techniques, an entire pit or trench could be circumscribed; such perimeter surveys could be performed at several distances from the pit or trench to yield a detailed three-dimensional image of the distribution of gross-beta and gamma activity. Selected salient 'hot' spots could be cored subsequently so that radionuclide-specific analyses could be generated and correlations between known species and activities and the gross counts developed. Likewise, the distribution of activity within a pit or trench could be determined. Because the spatial resolution of the technique is potentially high, detailed mapping of the functional stratigraphic features, responsible for groundwater flow, may be possible for the first time due to the radioactive 'label' contained in this region of the Conasauga. This could be implemented by acquiring a modestly-priced piece of drilling equipment with a track-mounted drill-head (e.g. the Hologator of Acker Tool Co.) and development of GM detector 'well point'; the detailed characterization of the three dimensional distribution of radioactivity around each pit and trench then may be possible.

The pits' and trenches' area has been very extensively studied for hydrologic characteristics. The work of deLaguna et al. (1958) described the results of pump tests (drawing 28161) at the pit 4 site, seepage rate determinations for the formation (drawings 21681 and 28382), pressure testing of the formation to depths of 200 feet (drawing 11942), and water table elevation maps (drawings 13396A and 28159) based on an extensive monitoring well network (drawing 11924A). These distributions of radioactivity at points in time (drawing 21602) and as a function of time (drawing 21603R) could well be interpreted as a detailed groundwater tracer test. Radioactivity was logged with depth below pit 4 as a function of pit usage (drawing 15480A). Extensive tracer tests were run (drawing 11944A) at the nearby '4 acre site' (see PHOTO-15895 with labels) which was a candidate site for a new seepage pit but

was eventually used as a test site for hydrofracturing experiments. The movement of nitrate tracer from an experimental unlined seepage pit (drawings 4964A-4966A) as well as water table responses to seepage were also studied in 1954 on an adjoining hillock later to become part of SWSA 6; the location of this covered experimental pit can be seen in PHOTO-15903. The movement of tritiated water at the pit 4 site was later studied (drawing 64-7897) and groundwater velocities of 0.5 ft/day were observed (Lomenick et al. 1964).

The streams draining the pits' area were also extensively investigated under low-flow conditions (drawing 29285) and in response to storm events (drawing 29284). The radioactivity discharges of these streams were followed in detail in 1957-1958; routine monitoring, with flow-proportional sampling, continues to the present although records were not kept between 1968 and 1980.

Discharges of seeps in the area were updated only once by Duguid (1975). Olsen et al. (1983) described the water table dynamics of the trench environs during a period of characterization in 1981-1982 for potential corrective actions to its ^{60}Co -contaminated groundwater seep.

In terms of surface water discharge characteristics, information is presently being obtained for the eastern and western drainages in the pits' area. Surface runoff channels immediately east and west of trench 7 will soon be continuously monitored as part of a project to evaluate the effectiveness of some corrective actions to be taken at trench 7 later this year; these actions include widening the asphalt cap on the trench and routing of surface runoff away from the trench and grouting the soil formation between the trench and its eastern seep (Stansfield 1984). The only unmonitored drainage remaining in the area will be the remainder of the 14 ha area between trenches 5, 6, and 7. If a weir were installed on this drainage, a complete surface water monitoring network would be available for the area. Provisions would have to be made for a central data collection and storage system and a hydrologic interpretation of this data would need to be made to summarize the output into a water budget. If this activity were to include water table elevation monitoring and seep discharge monitoring, as described previously, then the complete hydrologic characterization of the area could be completed in a two year observation period. This observation period would provide the information required to construct the needed hydrologic models of the area.

Detailed investigations of the soils in the pits' and trenches' area would be largely a superfluous effort. Detailed information is already available for two proximate sites: one in SWSA 6 (Davis et al. 1984) and another in proposed SWSA 7 (Rothschild et al. 1984). Both these sites have soils developed in the same portion of the Conasauga and have essentially identical geomorphology and vegetation. Similarly, meteorologic characterization of the area would

CP-
Not be reg
obtained in
the Oak Ridge
characteristic
storms, flood
politics

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not be required because adequate data continues to be obtained in SWSA 6 and SWSA 5 and at several other sites on the Oak Ridge Reservation. Similarly, regional characteristics for such things as seismic activity, severe storms, flooding, ecology, and social, economic, and political characteristics can be used verbatim from other recent studies (e.g. Boyle et al. 1982).

OAK RIDGE NATIONAL LABORATORY
LABORATORY DIRECTOR'S REVIEW COMMITTEES

Committee: Waste Effluents

Meeting Date: October 17, 1961

Code Number:

Present:

Members

Experimenters or Operators

W. H. Jordan, Chairman

J. A. Cox

W. A. Arnold

G. A. Cristy

K. B. Brown

W. DeLaguna

G. C. Cain

D. G. Jacobs

F. Kertesz

R. G. Jenness

E. Lamb

L. C. Lasher

M. L. Nelson

S. J. Rimshaw

A. F. Rupp

E. G. Struxness

Problems Presented by Leakage from Trench No. 6

Chairman Jordan announced that management requested the Committee to review the situation arising out of the recently noticed leakage of radioactive materials from Trench No. 6.

Cox described the present situation. The trench in question has been in use since September 10. On October 5 sampling revealed the presence of strontium in a seep below the trench. Up to this occurrence none of the earth disposal systems ever failed to retain strontium. The seep occurs about 100 yards below the trench; the liquid seeping through amounts to 0.15 gallons/minute. It is intended to prepare a synthetic soil column by adding clay and shale to the seepage area. Instructions were given immediately to stop release of radioactive waste into this trench. The chemistry of the waste system is currently being studied by S. J. Rimshaw. On the basis of previous studies it appears desirable to add caustic solution to the trenches. As long as this trench cannot be used, Pits No. 2, 3 and 4 will be used again. It is of interest to note that Trench No. 5 which has been in use for more than a year still operates satisfactorily. The reason for this failure might be due to geological or hydrological properties of the region.

DeLaguna reviewed the problem from the geological viewpoint. The recommended location of the trenches was chosen on the basis of experiences gained with the open pits. Reference is made to the "ORNL Seepage Pit Requirements" which was published in the Health Physics Annual Report for July 31, 1957 (ORNL-2384). A copy of these requirements is included in the attachments (received after the meeting).

Pits No. 2, 3 and 4 were located on a ridge with a steep slope east of Pit No. 4. Bed rock in the area of the pits and trenches lies in beds extending east and west and dipping south. Pit No. 1 was used for only a short time and its use was discontinued quite some time ago. Pit No. 2 operates quite well passing 3,200 gallons/day; it contributed only small amounts of ruthenium to the lake. Pit No. 3 passes about 1,000 gallons/day. Most of the liquid moves out in a direction parallel to the bedding of the weathered shale; the unweathered shale below a depth of about 20

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Meeting Date: October 17, 1961
Subject: Problems Presented by Leakage from Trench No. 6

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Trench No. 5 has operated quite well for over a year taking care of about 1/2 of the intermediate-level liquid radioactive waste from the Laboratory. It was then decided to build another similar one, and a reconnaissance was made of a nearby similar ridge. On the basis of this examination two possible sites for Trench No. 6 were suggested for further study (see attached map). Experience has shown that it is unwise to attempt to estimate the depth of the water table under these ridges and test holes were recommended. One of our test wells near where Trench No. 6 was actually built showed depths to the water table of from 14 to over 20 feet, but the minimum is probably less. In view of the seasonal variations the exact depth of the water table below Trench No. 6 is not known but while it was being dug the shale was dry to a depth of 15 feet. On the basis of past experience it is quite possible that the water table will rise above the bottom of the trench in wet weather, even after the trench is abandoned. The depth to the water table at the suggested locations is greater.

Although some shallow auger holes were apparently drilled, neither the sites suggested nor the test drilling recommended were actually made use of. The first observation wells around Trench No. 6 were drilled after the trench was in service. The first observations were made about 10 days ago (October 5) and the depth of water in these wells (seven) varied from 12 to 18 feet. It was this very shallow depth to water that lead to the search for the seep below the trench, and it should be kept in mind that the highest water table will come in January or February when the weather is rainy and the effect of evaporation is negligible. Also the flow of seep will probably increase materially at this time. There is some limestone in the area of Trench No. 6 but it is unlikely that it contributes materially to the flow of waste to the seep. In checking the various holes very little activity was found in the ones north of the trench but in the three holes to the south quite considerable amounts of activity were noticed.

When the trench was built on this site it was felt that it would percolate through the shale too slowly; actually the present rate is 4,000 to 5,000 gallons/day. The evidence suggests that as the water table came up due to seepage from the trench, the flow was concentrated at a shallow depth into the draw to the south. Logging the holes with a GM Probe suspended on a cable shows concentrated flow in this one direction. There is little or no flow through the shale in depth, largely because of the location and orientation of the trench.

If waste continues to pour into this trench the water table will continue to be high and the radioactive materials absorbed on the shale will be soaked and leached annually by the ground water. Geologically the trench has been improperly located; however, potentially favorable locations for trenches are still available assuming that test drilling shows a favorable depth to the water table. Construction of a new properly located trench appears to be more desirable than trying to improve a basically poorly located one. The effectiveness for long-term retention of strontium by attempted remedial action at the seep is problematical.

Although some auger holes were drilled in one of the locations suggested for study no systematic investigations of these areas has yet been made. A detailed topographic map of the area would be desirable. The presently available topographic

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map was made from aerial photographs but because the area is heavily wooded the topography is not accurate. It should be emphasized that even under the best conditions there is a certain amount of gamble in any trench location, but that careful site selection (including test drilling) can reduce the hazard.

In the discussion it was brought out that the actual choice of the site of Trench No. 6 was made by Engineering and Mechanical Division on the basis of cost estimates. It appears that at that time the possible geological objections were not known to them. A large amount of the \$30,000 cost of the trench is due to the construction of the required new pipe line. Construction of the trenches was pushed in order to make them available as rapidly as possible for replacing the open pits. Proposed treatments to improve the present situation include sealing the top and the use of stabilizing compounds.

Lasher gave the curie amount of radioactive materials in this trench: strontium-90, 110; strontium-89, 15; total ruthenium, 52; cesium, 338; rare earths, 130. These amounts are negligible compared to those in the other trenches and pits. In order to make sure that this material will not migrate anywhere else the whole trench will be covered over.

Jacobs reviewed the problem from the chemical viewpoint. Strontium causes the chief concern; the cesium is much less important. Recent pH measurements at the seep showed that the solution pumped out had a pH of 10*. In the past few years these solutions contained an average of 0.2 molar NaOH. Accordingly, the hydroxyl concentration is considerably reduced; the soil acts as a weak acid buffering system neutralizing the basicity of the solution. The pH value of the Conasauga shale is between 4.5 and 5.2. Addition of 0.2 molar sodium hydroxide solution in the shale will have a neutralizing effect at a considerable distance from the point of introduction. While the hydroxyl concentration of lower pH solution will be lowered much nearer the point of discharge, strontium in the waste amounts to about 100 curies as compared to a total activity of 400 to 500 curies. In the past about 85% of the activity was due to cesium, 1 to 2% to strontium. It is known that whenever the pH value is low the strontium will start to move and it should be remembered that the soil in that area is loaded with calcium. There is too much calcium in the soil to make possible much pickup of the strontium and accordingly any strontium that is already moving will continue to move and will not be retained. However, if the pH is increased to a very high value and the calcium is replaced by sodium then the situation will be reversed. Thus it can be concluded that the trench did not have a good opportunity to perform as planned in view of the pH value of 9.8 at which calcium hydroxide and even more strontium hydroxide are quite soluble. The pH value of the seeps at several hundred feet distance is 4.9. Under these conditions, about 80% of the exchange sites are occupied by calcium and sorption of strontium is low.

The lowering of the pH is due to decaying plants forming humic acid. From the behavior of the cesium it can be concluded that the solution passes through the soil very rapidly resulting in poor contact. This behavior suggests channeling.

* Titration indicated a hydroxyl concentration of 0.04 M, corresponding to pH 12.6.

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No complete clay mineral analysis of this site has been made yet; in the original pit area the active material consisted mostly of illite. Other shale constituents amounted to about 20%.

With respect to strontium phosphate fixation at high pH values, it should be remembered that the strontium phosphate $\text{Sr}_3(\text{PO}_4)_2$ is more insoluble than the corresponding calcium salt and so strontium will be taken up. At the lower pH values the compound SrHPO_4 is more soluble than the CaHPO_4 . If strontium containing waste together with phosphate ions are passed over calcium carbonate, apatite will be formed. The calcium carbonate as such will not pick up strontium. Only after the apatite lattice is formed can strontium sorption be initiated. In the present case the phosphate reaction has not proceeded far enough to start picking up the strontium. One way to accelerate this is to add phosphate into the waste before it is released in order to start the first part of the reaction. Rimshaw added that the pits are filled with calcium carbonate. If the carbonate rocks could be coated with phosphate the resulting system would be very efficient. A similar method is used by the French in Saclay. The behavior of this salt is greatly dependent on the pH: increasing the pH value above 10, the retention of the strontium will be improved but not that of cesium.

During the discussion it was brought out that the analysis of the seep is not consistent with the inventory because all the material does not come out and it is difficult to determine the exact concentration held on the shale. The opinion was expressed that the difficulty may be due to a problem arising at the end of the trench. That area could be closed off with a cofferdam.

Cristy presented the results of the seismographic investigations. Unfortunately at present the seismographic method is not as precise as would be desirable. At the time the trench was dug large rock formations were found in the middle of the desired location. In view of the great cost of rock removal seismographic soundings were taken in order to determine the depth of the rocks before starting drilling operations. The instrument based on the determination of the rate of propagational sound waves stops counting after the first shock wave hits the sensor. The depths can be calculated from the difference of velocity of the waves which is about 1100 ft/second in air and 5000 ft/second in solid rock. The soundings gave values of 35 to 50 ft of average depths. In some cases rock was found close to the surface. No consistent readings were obtained throughout the area. The results only allow the conclusion that in certain locations there is some rock close to the surface throwing the seismographic readings off.

Jordan expressed the opinion that it is fortunate the trouble was found so soon. At present the situation does not constitute a hazard but it would if the waste disposal would be continued. He felt that the exact reason for the difficulty and solution to overcome it must be known before the trench can be used again.

Rupp pointed to the great investment represented by the trench and indicated that it would be very desirable to use them up to the limit of their capacity, perhaps to dispose 500 to 1000 gallons per day after a safe limit is established on the

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basis of the current investigation. Of course, more data are needed for intelligent action. No more ditches will be constructed for waste disposal. It is hoped that the recirculation system to be installed will help reduce the volume of the waste effluents and improve the situation.

The public relation aspect of the pits still in operation must be considered by the Committee; the ruthenium which is in the system must be removed. It is very advantageous that the current waste effluents contain very little ruthenium.

Recommendations:

The exact mechanism whereby the strontium and other isotopes have moved so rapidly to nearby wells and seeps is not understood, although several possibilities have been considered. The Operations Division plans to continue their investigation in hopes of salvaging some use of the trench. Meanwhile, no more radioactive liquid is being dumped into the trench.

The choice of location of Trench No. 6 appears to be unfortunate in that it is so near to ground water. It may even be that during the rainy season the level of ground water may be above the bottom of the trench, even if no liquid is pumped into the trench. Thus, even after the trench is abandoned there will be continued leaching of the radioactivity absorbed on the soil.

The amount of radioactivity that has been dumped into Trench No. 6 is relatively small (some 100 curies of strontium) and does not appear to be a serious hazard. However, if plans should develop to put some waste into this trench, the Committee would like to review such plans before they are executed. The Committee endorses Operations' plan to add caustic to Trench No. 6 and recommends that all waste be treated with caustic before being dumped into any pit. This should help tie up the radionuclides in the soil.

Submitted by W. J. Jordan for
Francois Kertesz, Executive Secretary
Laboratory Director's Review Committees

October 25, 1961

FK:bMcH

Attachments: 2

Spalding
2-28-85

Excerpts from Operations Division Monthly Reports
Pertaining to the Seepage Pits and Trenches

Month ending July 31, 1951 (ORNL-1109 p. 9)

In cooperation with the Health Physics Division, a site beyond the new burial ground [SWSA 4] has been chosen to locate a 200,000-gallon lagoon for the storage of metal-waste supernatant now stored in tank W-10. This location provides a shale which will allow very little seepage over geologically long periods of time. This is expected to be a much safer and cheaper way of permanently disposing of liquid wastes. This project is considered to be an experiment at the present time. Approximately 100,000 gallons containing about 100 curies of activity will be stored there until this method of disposal is proven to be safe and economically practical.

Month ending August 31, 1951 (ORNL-1122, p. 12)

The transfer of radiochemical metal waste supernate from W-10 to the chemical waste storage pit was begun on August 1, 1951, and discontinued on August 7, 1951, after a total of 26,400 gal, bearing 22.88 curies of beta activity, 134 kg of uranium, and 28.15 mg of plutonium was transferred. The transfer from this tank was discontinued because of the high uranium content. Further precipitation by the addition of 850 gal of 50%-caustic was made.

While the precipitate in tank W-10 was allowed to settle, a total of 15,000 gal of evaporator concentrate was transferred from W-8 to the storage pit. This transfer was started on August 7 and completed on August 10. The material carried 192.4 curies of beta activity, 15.5 kg of depleted uranium, and 8.48 mg of plutonium.

The entire transfer operation was successfully carried out. Two portable 500-gal tanks with the Dempster Dumpster truck were used. The operation presented no undue amount of radiation hazard.

Month ending September 30, 1951 (ORNL-1127, p. 7-8)

The transfer of radioactive metal waste supernate from W-10 to the chemical waste storage pit was resumed on September 24, 1951. The amount transferred from September 24 through September 30 was 43,200 gal, bearing 33.6 curies of beta activity, 17.7 kg of uranium, and 76 mg of plutonium.

The transfer of waste will continue until an adequate amount of free space is made available to transfer the contents of W-7 to W-10.

Month ending October 31, 1951 (ORNL-1156, p. 9)

The transfer of radioactive metal waste supernate from W-10 to the chemical waste storage pit was resumed October 1, 1951, and continued through October 3, 1951. In the 24,600 gal of material transferred, there were 18,622 g of uranium, 65 mg of plutonium, and 8.2 curies of beta activity.

Transfer of chemical waste concentrate from W-8 to the pit was begun

on October 3, 1951, and continued through October 5, 1951. This 13,000 gal of waste contained 132.3 curies of beta activity, 8.8 mg of plutonium and 10,238 g uranium.

The volume of waste in the chemical waste storage pit is decreasing at a rate of 500 to 600 gal per day and the plants near the pit have been found slightly radioactive. The Health Physics Division has the area under its surveillance.

Month ending November 30, 1951 (ORNL-1188)

No mention.

Month ending December 31, 1951 (ORNL-1212, p. 23)

At the suggestion of the Health Physics Division, additional storage space was provided last fall by transferring 123,000 gal of a mixture of evaporator concentrate and metal-waste supernatant to a 170,000 gal pit dug for this purpose southwest of the new burial ground [SWSA 4]. This method was to be considered an experiment which, if it proved to be practical, would pave the way for a simple and very economical method of permanent disposal of concentrated evaporator wastes. The pit and the surrounding area are still under Health Physics surveillance; no decision concerning the practicality of this method has yet been made.

Month ending January 31, 1952 (ORNL-1245)

No mention.

Month ending February 28, 1952. (ORNL-1259)

No mention.

Month ending March 31, 1952 (ORNL-1271, p. 12)

Construction of a new chemical-waste storage pit for hot chemical waste was about 50% complete at the end of the month [Pit 2].

Month ending April 30, 1952 (ORNL-1295, p. 10)

Work on the new chemical-waste storage pit [Pit 2] has progressed until the project is about 97% complete.

Month ending May 31, 1952 (ORNL-1319, p. 10)

The chemical-waste storage pit [Pit 2] was completed this month.

Month ending June 30, 1952 (ORNL-1334, p. 11)

Approximately 12,000 gal of contaminated chemical waste that contained 187.0 beta curies were transferred from tank W-8 to lagoon No. 2 [Pit 2] this month. The radiation levels are high, so the transfer operation is confined to two shifts per week.

Month ending July 31, 1952 (ORNL-1363)

No mention.

Month ending August 31, 1952 (ORNL-1390)

No mention.

Month ending September 30, 1952 (ORNL-1404)

The movement of concentrated chemical waste from tank W-8 to chemical-waste pit No. 2 was resumed. There was 4200 gal of waste containing 103 curies of beta activity transferred, which brings the total amount transferred to date to 16,200 gal bearing 290 curies of beta activity.

Month ending October 31, 1952 (ORNL-1440, p. 9)

Approximately 900 gal of concentrated chemical waste from tank W-8, which contained 28.3 curies of beta activity, was moved to chemical-waste pit No. 2. The total transferred to this pit to date is 17,100 gal and bears 318 beta curies of activity.

Month ending November 30, 1952 (ORNL-1460, p. 9)

Approximately 16,200 gal of concentrated chemical waste from tank W-8, which contained 400 curies of beta activity, was moved to chemical-waste storage Pit No. 2. The total transferred to date is 33,000 gal bearing 718 curies of beta activity.

Month ending December 31, 1952 (ORNL-1485, p. 19)

Approximately 9600 gal of concentrated chemical waste from tank W-8, which contained 235 curies of activity, was moved to chemical waste pit No. 2. The total transferred to date is 42,600 gal bearing 953 curies of activity.

Month ending January 31, 1953 (ORNL-1502)

No mention.

Month ending February 28, 1953 (ORNL-1522, p. 10)

The tank trailer, with a capacity of about 4000 gal, for hauling concentrated chemical wastes from the tank farm to the waste storage pit was put into service this month. There was 45,600 gal, bearing 1131 curies of beta activity, transferred this month to give a total transferred to the pit to date of 55,200 gal containing 1366 curies of beta activity. The use of this equipment enables transfer of larger volumes of wastes with lower personnel radiation exposure than was encountered with the 500-gal tanks previously used.

Month ending March 31, 1953 (ORNL-1539, p. 9)

A total of 21,600 gal of chemical-waste concentrate bearing 615.28 curies of beta activity was discharged to the chemical-waste storage pit No. 2 from tank W-8. The total transferred to date from the concentrate tank to the pit is 76,800 gal containing 1981 curies. Additional wastes, consisting of 600 gal bearing approximately 15 g of U-235 and 16 curies of beta activity from the Homogeneous Reactor Building and 6500 gal bearing approximately 6.13 curies of beta activity from the washings of the pit excavation at valve group No. 1 in the north tank farm, were also transferred to the same waste pit.

Month ending April 30, 1952 (ORNL-1553, p. 9)

There was 37,800 gal of chemical-waste concentrate containing 1897 curies of beta activity discharged to chemical-waste storage pit No. 2 from tank W-8. The total transferred to date from the concentrate tank to the pit is 114,600 gal bearing 3878 curies.

Month ending May 31, 1953 (ORNL-1564, p. 12)

There was 28,800 gal of chemical-waste concentrate containing 1377 curies of beta activity discharged to chemical-waste storage pit No. 2 from tank W-8. The total transferred to date from the concentrate tank to the pit is 143,400 gal bearing 5255 curies.

Month ending June 30, 1953 (ORNL-1586)

No mention.

Month ending July 31, 1953 (ORNL-1603)

No mention.

Month ending August 31, 1953 (ORNL-1619, p. 14)

A total of 29,400 gal of chemical-waste concentrate bearing 995 curies of beta activity was transferred from waste tank W-8 to waste storage pit No. 2. The total transferred to date is 172,800 gal containing 6250 curies of beta activity.

Month ending September 30, 1953 (ORNL-1635, p. 12)

A total of 32,400 gal of chemical-waste concentrate bearing 899 curies of beta activity was transferred from waste-tank W-8 to chemical-waste storage pit No. 2. The total transferred to date is 205,200 gal containing 7149 curies of beta activity.

Month ending October 31, 1953 (ORNL-1646, p. 12)

A total of 31,200 gal of chemical-waste concentrate bearing 802 curies of beta activity was transferred from waste-tank W-8 to chemical-waste storage pit No. 2. The total transferred to date is 236,400 gal containing 7951 curies of beta activity.

Month ending November 30, 1953 (ORNL-1654)

No mention.

Month ending December 31, 1953 (ORNL-1668, p. 12)

Construction of the pump pit in the south tank farm has been started. This pit is for the waste line from the tank farm to the chemical-waste storage pit No. 2.

Year ending December 31, 1953 (ORNL-1680, p. 14-16)

Approximately 227,000 gal of concentrated radioactive waste containing 7716 curies of beta activity was transferred from the tank farm to the chemical-waste storage pit No. 2. The total transferred to the pit thus far is 270,000 gal containing 8669 curies (Fig. 3) [ORNL-PHOTO-12116].

A speed-up in the transfer of waste to the pit and an appreciable reduction in exposure of man power to radiation was accomplished by using an old, salvaged gasoline trailer which was excoerced by the AEC and converted for waste-hauling purposes at the Laboratory. This equipment was far superior to the 500-gal Dempster Dumpster tanks originally used.

Construction of a pipe line connecting the tank farm to the waste-storage pit is expected to be completed early in 1954. This project will eliminate the hazardous hauling of waste by truck, will probably eliminate the need for concentrating wastes by the waste evaporator, and will greatly reduce the amount of effort and money expended in the disposal of liquid wastes.

[break] The construction of the pipe line to the waste-storage pit will eliminate the need for more chemical-waste storage tanks and will provide a safer and cheaper way of permanently disposing of the "hot" chemical wastes.

Month ending January 31, 1954 (ORNL-1683, p. 10)

Construction has been started on the transfer line from the south tank farm to chemical-waste storage pit No. 2. Construction continued on the pump pit for the waste transfer line in the south tank farm.

A total of 12,600 gal of chemical-waste concentrate bearing 262 curies of beta activity was transferred to chemical-waste Pit No. 2 this month. This brings the total transferred to date to 282,600 gal containing 8930 curies.

Month ending February 28, 1954 (ORNL-1699, p. 10-11)

A total of 49,200 gal of concentrated chemical waste bearing 1173 curies of beta activity was transferred to chemical-waste storage pit No. 2. This brings the total transferred to date to 331,800 gal containing 10,104 curies.

[Break]

Construction of the waste transfer line from the tank farm to the chemical-waste storage pit has been completed by the contractor. The construction of the pumping station by the Laboratory forces continues and is scheduled to be completed in April, when delivery of the pump is

expected.

Month ending March 31, 1954 (ORNL-1710, p. 12)

A total of 11,800 gal of nonradioactive concentrated chemical waste was transferred to chemical waste storage pit No. 2. Of this amount, 5000 gal was $\text{Al}(\text{NO}_3)_3$ waste from Unit Operations, Building 4505, and 6800 gal was NH_4NO_3 from metal recovery operations, Building 3505.

Month ending April 30, 1954 (ORNL-1730, p. 10)

The trailer used to haul radioactive wastes was temporarily removed from service for emergency repairs after it received serious corrosive attack from acidic wastes. One new surplus trailer has been procured to replace the damaged one since it could not be put back into its original good condition; another surplus trailer was also obtained as a spare.

[break]

A total of 29,160 gal of radioactive and inactive chemical wastes were transferred to chemical-waste storage pit No. 2. Of this amount, only 400 gal, received from the decontamination of the homogeneous reactor, was radioactive; it contained 0.696 beta curies. The remaining volumes were 10,550 gal of $\text{Al}(\text{NO}_3)_3$ waste from Unit Operations, Building 4505; and 18,210 gal of NH_4NO_3 from metal recovery operations, Building 3505.

Month ending May 31, 1954 (ORNL-1743, p. 8-9)

The trailer used to haul contaminated wastes was removed from service twice for emergency repairs because of leakage. The replacement trailers are at the shops awaiting alterations.

The black-iron drain line from the waste trailer unloading area to the waste storage pit was completely destroyed by low-pH wastes. The drain line was replaced with one made of terra cotta.

The pumping station in the line from the tank farm to chemical-waste storage pit No. 2 is essentially complete. Some minor work remains to be performed before the project is accepted for use. The equipment has been tested and meets the manufacturer's specifications.

[break]

A total of 26,613 gal of waste contaminated with natural uranium was transferred to chemical-waste storage pit No. 2. Of this amount, 4420 gal of $\text{Al}(\text{NO}_3)_3$ was received from Unit Operations, Building 4505, and 18,193 gal of NH_4NO_3 from metal recovery operations, Building 3505.

Month ending June 30, 1954 (ORNL-1752, p. 9-10)

The installation of the pumping station for the pipe line to the waste pit was completed and the waste transfer pipe line put into service on June 2. The performance of the pump was highly satisfactory; at 120-psi pump discharge pressure, the delivery rate was 1800 gph, 600 gph more than the expected rate.

With the successful beginning of the waste transfer line operation, the waste evaporator was shut down and put in a standby condition. Hot

wastes are now being pumped directly to the pit without a reduction in volume. The elimination of this operation is expected to reduce waste handling costs.

With the operation of the pipe line, it was also possible to eliminate usage of the waste trailer for hauling the concentrated NH_4OH wastes from the Metal Recovery Building. This waste is now being discharged to the tank farm storage tanks, where it is pumped to the waste pit along with the radioactive wastes.

A total of 99,460 gal of wastes, containing 1492 curies of beta activity, was transferred to the pit this month. Approximately 88,800 gal was transferred through the new pipeline and contained all the activity; 6700 gal was concentrated NH_4OH transported by tank truck from the Metal Recovery Building, and 3960 gal was $\text{Al}(\text{NO}_3)_3$ transferred by tank truck from the Unit Operations Building.

Month ending July 31, 1954 (ORNL-1764, p. 9-10)

Radioactive wastes containing 4666 curies (133,800 gal) were pumped from tank W-8 to chemical waste storage pit No. 2. In addition, 4127 gal of highly concentrated inactive $\text{Al}(\text{NO}_3)_3$ and NH_4NO_3 waste was transferred to the pit from Unit Operations. Building 4505, and the metal recovery operations, Building 3505. The total of all wastes discharged to waste storage pit No. 2 to date is 628,633 gal containing 16,263 curies.
[break]

The trailer tank used to haul wastes to the chemical-waste pit was discarded because of leaks which could not be repaired. Surplus trailer tanks recently acquired are being repaired and their designs are being revised for plant use; one of these trailers should be available next month. Meanwhile, all wastes scheduled for pit disposal are being pumped to the chemical-waste pit.

Month ending August 31, 1954 (ORNL-1787, p. 9)

A 130,200-gal quantity of radioactive wastes containing 415 curies of radioactivity was pumped from tank W-8 to chemical waste storage pit No. 2. In addition, 4025 gal of highly concentrated inactive $\text{Al}(\text{NO}_3)_3$ waste was transferred to the pit from Unit Operations, Building 4505. The total of all wastes discharged to waste storage pit No. 2 to date is 762,858 gal, containing 16,678 curies.

The pump used to transfer wastes from tank W-8 to waste storage pit No. 2 failed and had to be removed for repair. Inspection revealed a plugging of the suction line and the pump casing with an unidentified white precipitate readily soluble in HNO_3 . The pump was reinstalled and now operates satisfactorily.

Month ending September 30, 1954 (ORNL-1804, p. 10)

Radioactive wastes containing 744 curies in a volume of 165,600 gal were discharged into chemical-waste storage pit No. 2 from tank W-8. The total of all wastes discharged to waste storage pit No. 2 to date is 928,458 gal containing 17,422 curies. The chemical-waste system received 113,400 gal of waste during the month.

Alterations to the new hot-waste tank trailer have been completed.

Month ending October 31, 1954 (ORNL-1822, p. 9)

A total of 167,550 gal of wastes, containing 277.0 curies, was transferred to chemical storage pit No. 2 this month. Of the total, 3750 gal was not active and was trucked from Unit Operations Building 4505. The total of all wastes discharged to waste storage pit No. 2 to date is 1,095,708 gal containing 13,661 curies. (The curie figure has been erroneously reported 4038 curies too high since July, 1954, as the result of a calculating error.)

A total of 181,400 gal of waste was put through the chemical-waste system.

An additional line to the pump from the tank farm to chemical-waste storage pit No. 2 was installed from waste tank W-6, but it is not yet working satisfactorily.

Month ending November 30, 1954 (ORNL-1831, p. 10)

A total of 49,650 gal of wastes containing 2036 curies was transferred to chemical-waste storage pit No. 2 this month. Of the total, 450 gal was not active and was moved by truck from Unit Operations Building 3503. The remaining wastes were pumped from chemical waste tank W-6. This is the first time that waste has been pumped successfully from this tank. The total of all wastes discharged to the waste storage pit No. 2 to date is 1,145,358 gal containing 15,697 curies.

The chemical-waste system received 73,200 gal of waste during the month.

Another chemical-waste storage pit located adjacent to chemical-waste storage pit No. 2 is under construction. The capacity of this new pit will be 1,000,000 gal, the same as that of pit No. 2. Construction should be completed during December.

Month ending December 31, 1954 (ORNL-1841, p. 9)

A total of 116,400 gal of wastes containing 196 curies was transferred to chemical-waste storage pit No. 2 this month from chemical-waste tank W-6. The total of all wastes discharged to the waste storage pit No. 2 to date is 1,261,758 gal containing 15,893 curies. There was 88,000 gal of waste put into the chemical-waste system.

Chemical-waste storage pit No. 3 is still under construction. The pit now lacks only a gage board and protective fencing for completion. [break]

A piece of the transfer pipeline to the waste storage pit from the south tank farm was removed to allow revisions for servicing the new waste storage pit. Visual inspection of this piece of pipe indicated that no undue corrosion or wear has resulted from its use during the first seven months of operations.

End of Series published as ORNL-XXXX Reports.

SOLID WASTE MANAGEMENT SITES AT ORNL

[illegible]

W. J. L.

- [illegible]

1. Sewage Aeration Pond (widened)

2. Oil Settling Basin

3. Intensity Test Reactor

4. Filter Pit (Fission)

5. LLW Transfer Line

6. LLW Collection

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2. 1990-1991 Communication Project (1990)

19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1049 1

14 UNITS
ALLW LIVE LEAKS
7 PITS & TRENCHES
3 MISC

c = 7907

d = 7908

5. Hydrofracture Experimental Site 1, 341, Contamination (-F-53)

a. L&W Line and Leak Sites - e. d. Alley Drive Area

b. Melton Valley Drive

c. Melton Valley Drive and 504-2 Address Area

d. 7500 Area

e. West of Melton Valley Pumping Station

f. Slog. 7550 and IV Pumping Station Area

g. Slog. 7550 Slog. Line

h. The Melton Valley Pumping Station

i. The Melton Valley Pumping Station

j. The Melton Valley Pumping Station

k. The Melton Valley Pumping Station

l. The Melton Valley Pumping Station

m. The Melton Valley Pumping Station

6. Solid Waste Storage Area - 7507

a. Solid Waste Storage Area - 7507

7. Solid Waste Storage Area - 7508

8. Solid Waste Storage Area - 7509

a. Solid Waste Storage Area - 7509

b. Solid Waste Storage Area - 7509

c. Solid Waste Storage Area - 7509

d. Solid Waste Storage Area - 7509

e. Solid Waste Storage Area - 7509

9. Hydrofracture Injection Wells and Grout Sheets

a. Hydrofracture Experimental Site 1 (-F-53)

b. Hydrofracture Experimental Site 2 (-F-53)

c. Hydrofracture Facility (7550)

d. Hydrofracture Facility (7550)

10. Wing Scrap Yard

a. Wing Scrap Yard (7507)

11. Contractors' Landfill

a. Contractors' Landfill (7508)

12. Material Research Area

13. Material Research Area - 7509

3.2 Cesium-137 Erosion/Runoff Study Area (0807)

Shielding Facility (0808)

1. 100' Erosion Yard (7702)

2. 100' Erosion Tank (7703)

3.3 Facilities at 7700

1. 100' Erosion Yard (7702)

2. 100' Erosion Tank (7703)

3.4 Facilities at 7700

1. 100' Erosion Yard (7702)

2. 100' Erosion Tank (7703)

3.5 Facilities at 7700

1. 100' Erosion Yard (7702)

2. 100' Erosion Tank (7703)

3. 100' Erosion Tank (7703)

4. 100' Erosion Tank (7703)

5. 100' Erosion Tank (7703)

6. 100' Erosion Tank (7703)

7. 100' Erosion Tank (7703)

8. 100' Erosion Tank (7703)

9. 100' Erosion Tank (7703)

10. 100' Erosion Tank (7703)

3.6 Facilities at 7700

1. 100' Erosion Yard (7600A, 7600B)

2. 100' Erosion Tank (7600A)

3. 100' Erosion Tank (7600B)

4. 100' Erosion Tank (7600C)

5. 100' Erosion Tank (7616)

6. 100' Erosion Tank (7602, 7601)

7. 100' Erosion Tank (7602a)

8. 100' Erosion Tank (7602b)

9. 100' Erosion Tank (7616)

10. 100' Erosion Tank (7602)

11. 100' Erosion Tank (7602)

3.7 Facilities at 7700

- 13.1 Hazardous Waste Storage Facility (7552)
- 13.2 Chemical Waste Storage and Disposal Area (7553)
- 13.3 Long-Term Hazardous Waste Storage Facility (7554)
- 13.4 Mixed Waste Storage Facility (7555)
- 13.5 Leaking Gas Cylinder Area - 7556
- 13.6 Reactive Chemicals Disposal Area - 7557

14.1 Hazardous Waste Storage Facility

14.2 Hazardous Waste Storage Facility - 7558

$\frac{d}{dt} \left(\frac{\partial L}{\partial \dot{x}} \right) = \frac{\partial L}{\partial x}$

- [illegible]

1. The first part of the paper is devoted to the study of the asymptotic behavior of the solutions of the system (1) as $t \rightarrow \infty$. It is shown that the solutions of the system (1) tend to zero as $t \rightarrow \infty$ if and only if the matrix A is Hurwitz. The second part of the paper is devoted to the study of the asymptotic behavior of the solutions of the system (1) as $t \rightarrow \infty$ if the matrix A is not Hurwitz. It is shown that the solutions of the system (1) tend to infinity as $t \rightarrow \infty$ if and only if the matrix A is not Hurwitz.

- “... 2000 年 12 月 31 日 23 时 59 分 59 秒”

[illegible]

- [illegible]

[2] [-----]

Date: 26 Mar 1985 1333-EST

From: T.E.MYRICK[TEY]

To: B.P.SPALDING[BPS]

Cc: N.H.CUTSHALL[NHC], D.D.HUFF[DDH], T.E.MYRICK[TEY], F.J.HOMAN[FJH]

Subject: REVIEW COMMENTS ON PITS AND TRENCHES REPORT

THE REPORT WAS AN EXCELLENT REVIEW OF THE EXISTING INFORMATION. I HAVE ONLY A FEW COMMENTS, LISTED AS FOLLOWS.

(1) BASED ON THE PRESENT REGULATORY ENVIRONMENT, WE HAVE NO OPTION BUT TO DISCUSS THE IMPACTS THAT RCRA/CERCLA REGULATIONS WILL HAVE ON THIS AREA. ALTHOUGH IT IS NOT CLEAR WHAT MAY HAPPEN IN THIS REGARD, THESE REGULATIONS MUST BE DISCUSSED IN THIS REPORT.

(2) ALONG THESE SAME LINES, THERE IS NO MENTION OF THE POTENTIAL CHEMICAL CONTAMINATION THAT IS PRESENT IN THE TRENCHES. I WOULD EXPECT, AS WOULD YOU I'M SURE, THAT THERE ARE HEAVY METALS, ETC. IN THESE PITS AND TRENCHES. THIS WILL BE THE CONTROLLING FACTOR IN THE END. THIS CHARACTERIZATION WORK NEEDS TO BE IDENTIFIED IN A BIG WAY.

(3) THE REPEATED REFERENCE TO MPC AS THE CONTROLLING RELEASE CRITERIA CANNOT BE SUPPORTED IN THE CURRENT REG. ENVIRONMENT. THE GUIDING REGULATIONS WILL LIKELY BE A DOSE LIMIT (50 MREM OR SO), RATHER THAN A CONCENTRATION IN WATER. SINCE THE MPC FIGURES ARE BASED ON 500 MREM, IT IS OBVIOUS THAT RESTRICTIONS WILL BE MUCH TIGHTER THAN THOSE YOU REFERENCE. WHILE IT IS GOOD TO HAVE THE COMPARISONS TO MPC IN ORDER TO GET A FEEL OF WHERE WE ARE AT IN RELATION TO A STANDARD, I FELT THAT THERE WAS TOO MUCH EMPHASIS GIVEN TO WHETHER WE ARE ABOVE OR BELOW THESE SOMEWHAT ARTIFICIAL GUIDELI

(4) THE HYPOTHETICAL CASE FOR EXPOSURE GIVEN IN THE LAST CHAPTER IS A PRIME EXAMPLE OF "MISUSE" OF THE MPC IN RELATION TO RELEASES FROM THESE AREAS. THIS EXAMPLE SHOULD REALLY BE REORIENTED OR DELETED.

(5) I WAS VURPRISED TO HEAR THAT THE PRESENT MONITORING CAPABILITIES IN THE AREA WAS SO SATISFACTORY. I EXPECTED TO HEAR THAT WE NEEDED FORE TO DETERMINE DOWN DIP TRANSFER OF CONTAMINATION. ALSO EXPECTED TO HEAR MORE ABOUT THE NEED FOR OBSERVATIONS OF THE PH CHANGES OF GROUNDWATER TO SEE IF THE ACTIVITY THAT IS TIED UP COULD BE RELEASED LATER. IT WOULD BE NICE TO HAVE A MAP OF THE CURRENT GROUNDWATER AND SURFACE WATER MONITORING LOCATIONS TO GET A FEEL OF HOW WE CURRENTLY "SURROUND" THE SITES.

(6) IS THERE ANY NEED TO MENTION OTHER SOURCES OF CONTAMINATION IN THE PITS AND TRENCHES AREA? FOR EXAMPLE, THE OLD ILW LINE AND THE HRE FUEL DISPOSAL SITES? THESE WILL CERTAINLY BE COMPLICATING FACTORS IN THE FINAL DISPOSITION OF THIS AREA, AND WE DON'T HAVE NEARLY THE CHARACTERIZATION DATA NEEDED TO ADDRESS THESE YET.

(7) COUPLE OF MINOR EDITORIAL ONES: PG. 36, FIRST PARAGRAPH, CHANGE MINIMAL TO ANNUAL..... CHANGE SOLID PHASE MOVEMENT TO SOMETHING ELSE (I'M NOT SURE WHAT YOU WERE GETTING AT).....ALSO ADD THE POTENTIAL FOR DIRECT RADIATION EXPOSURES (BUILDING A HOUSE ON IT OR DIGGING INTO IT).

OVERALL, I THINK WE'VE GOT A WINNER HERE, JUST NEED TO MAKE SURE WE DON'T OVERLOOK A FEW "PHILOSOPHICAL" POINTS. I'LL BE GLAD TO DISCUSS THESE

COMMENTS IN MORE DETAIL IF YOU NEED TO BEFORE THE FINAL GOES OUT. I
KNOW YOU ARE ON A TIGHT SCHEDULE.

Type "HELP" to get a list of commands.
MSG Read>

[1] [---D]

Date: 26 Mar 1985 1702-EST

From: T.E.MYRICK[TEY]

To: B.P.SPALDING[BPS]

Subject: Re: COMMENTS ON PITS AND TRENCHES REPORT

It is our opinion (current waste magmt) that the old ILW streams that went to the pits and trenches were likely loaded with hazardous wastes, since essentially everything liquid went in there. There were likely some very heavy-duty chemical R&D programs going on at that time, so these P&T could be a nightmare of haz waste. There's no need to scare anybody through this report without analytical backup, but I think we need to raise the issue a little more.

Type "HELP" to get a list of commands.
MSG Read> ACKNOWLEDGED

MSG> EXIT

There is 1 message to be deleted.

Delete it (yes)? YES

1 message deleted

October 30, 1961

for only a short time and its use was discontinued quite some time ago. Pit No. 4 operates quite well seeping at the rate of 3,200 gallons/day; it has contributed only small amounts of ruthenium to the lake. Pit No. 5 seeps about 1,000 gallons/day. Most of the liquid moves out in a direction parallel to the bedding of the weathered shale; the unweathered shale below a depth of about 20 to 30 feet is nearly completely impermeable. The side of Pit No. 5 has some limestone ledges which at first were suspected of forming long cracks or channels, but after the pit was filled no such channels were observed. If percolation from Pit No. 5 had been more rapid it would have been more successful but it was blocked partially by the location of Pit No. 2.

Pit No. 4 was built below Pit No. 2 and uncomfortably close to the seep line to the east. While there was some concern about this location, in view of the successful operation of the other two pits, the location was approved; however, a "patrol road" was built below it in order to monitor for possible seeps. Observation wells were built in this area both before and after the pits were in actual operation. After the pits were in operation for some time these wells showed the presence of ruthenium and a small amount of cobalt.

Evidence was obtained later that Pits No. 2 and 3 were above the water table when built; however, after the pits were operated for a certain time the water table rose as a result of the seepage and merged with the liquid level in the pits.

Flow from Pit No. 4 was found to be as much as 20,000 gallons/day. The movement of liquid is both to the east and to the west, parallel with the bedding; very little movement of the liquid is observed across the bedding. The end walls contribute virtually nothing to the seepage. Because the main flow is out of the pits in a direction parallel with the beds it appeared logical to build a narrow pit at right angles to the beds, filling it with broken stone. Such a narrow trench filled with stone and covered with dirt would fulfill the same function as the open pits while reducing the radiation field, which on occasion has reached 5 r/hr around the open pits. On the basis of these considerations we recommended a nearby place which had a level top and at this site a narrow trench (Trench 5) was dug to a depth of 15 feet. This was filled with rock, covered with dirt and, when placed in operation, performed satisfactorily. Since the trench was put in service, the water table level has risen 10 to 15 feet but it is still well below the level of the trench.

Pit No. 4 is completely abandoned and filled in, in which case the water table will drop. This will leave the strontium and ruthenium activity suspended in the shale immediately adjacent to the water table. This will also be the case with Trench 5; the future of Pits 2 and 3 is uncertain.

Trench No. 5 has operated quite well for over a year taking care of about 1/2 of the intermediate-level liquid radioactive waste from the Laboratory. It was then decided to build another similar one, and a reconnaissance was made of a nearby ridge. On the basis of this examination two possible sites for Trench No. 6 were suggested for further study (see attached map of Melton Valley). Experience has shown that it is unwise to attempt to estimate the depth of the water table under these ridges and test holes were recommended. One of our test wells near where Trench No. 6 was actually built showed depths to the water table of from 14 to over 20 feet, but the minimum is probably less. In view of the seasonal variations the exact depth of the water table below Trench No. 6 is not known but while it was being dug the shale was dry to a depth of 15 feet. It is quite possible that the water table will rise above the bottom of the trench in wet weather, even after the trench is abandoned. The depth to the water table at the suggested locations is greater.

Although some shallow auger holes were apparently drilled, nothing the sites suggested nor the test drilling recommended were carried out (Trench 6, as built, is shown on the map of Melton Valley). The first observation wells around Trench No. 6 were drilled after the trench was in service. The first observations were made about 10 days ago (October 5) and the depth of water in these wells (seven) varied from 12 to 18 feet. It was this very shallow depth to water that led to a search for the seep below the trench. It should be kept in mind that the highest water table will come in January or February when the weather is rainy and the effect of evaporation is negligible; also the flow of seep will probably increase materially at this time. There is some limestone in the area of Trench No. 6 but it is unlikely that it contributes materially to the flow of waste to the seep. In checking the various holes very little activity was found in the ones north of the trench but in the three holes to the south quite considerable amounts of activity were noticed. (See Table I.) The location of these holes is indicated on the attached Grading Plan.

Table I. Levels of Activity in Wells and Seeps
Around Trench No. 6 on October 13, 1961.

Well No.	c/m/ml Gross β (10% Geom)	P-106	d/m/ml Cs-137	d/m/ml Sr-90 ² 89	d/m/ml Co-60	c/m/ml TRE (10% Geom)
5	1.10×10^3	2.01×10^4	9.5	135	1.75×10^3	6.2
6	2.20×10^3	2.68×10^4	1.85	175	1.00×10^3	< 1.0
7	2.55×10^3	3.70×10^4	47.5	245	6.00×10^3	< 3.2
Seep	2.40	2.60×10^4	--	730	2.80×10^3	--
100' - Nelson, Trench 5 - after 1 1/2 years of operation.						
Well						
3		6.75×10^4	~30.0	< 1.7	2.51×10^3	none
7		1.26×10^5	~18.0	< 7.0	1.28×10^3	< 1.0
9		7.01×10^5	~21.0	none	1.08×10^3	< 6.2

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When the trench was built on this site it was felt that it would percolate through the shale too slowly; actually the present rate is 4,000 to 5,000 gallons/day. The evidence suggests that as the water table came up due to seepage from the trench, the flow was not directed at a shallow depth into the draw to the south. Logging the trench with a CM probe suspended on a cable shows concentrated flow in this one direction. There is little or no flow through the shale in other directions, largely because of the location and orientation of the trench.

If waste continues to pour into this trench the water table will continue to be high and the radioactive materials absorbed on the shale will be soaked and leached annually by the ground water. Geologically the trench has been improperly located; however, potentially favorable locations for trenches are still available assuming that test drilling shows a favorable depth to the water table. Construction of a new properly located trench appears to be more desirable than trying to improve a poorly located one. The effectiveness for long-term retention of strontium by attempted remedial action at the seep is problematical.

Although some larger holes were drilled in one of the locations suggested for study no systematic investigations of these areas has yet been made. A detailed topographic map of the area would be desirable. The presently available topographic map was made from aerial photographs but because the area is heavily wooded the topography is not accurate. It should be explained that even under the best conditions there is a certain amount of gamble in any trench location, but that careful site selection (including test drilling) can reduce the hazard.

In the discussion it was brought out that the actual choice of the trench location was made by the Engineering and Mechanical Division on the basis of information available at that time. It appears that at that time the possible problems of the trench were not known to them. A large amount of the seepage from the trench is due to the construction of the required new piping. Construction of the trenches was pushed in order to make them available as rapidly as possible for replacing the open pits. Proposed methods to improve the present situation include sealing the top and the bottom with stabilizing compounds.

D. G. Jacobs discussed his explanation of the reasons for movement of radionuclides in the vicinity of Trench No. 6. Analyses of soil and liquid at the seep showed the presence of Ru-106, Co-60, Cs-137, and Sr-90. In addition I-131 was identified in samples from observation wells. Although the former two radionuclides have always been known to move rapidly through the soil, previous ground disposal operations have been quite effective in preventing the movement of Cs-137 and Sr-90. Because the problem at hand is the fate of the Sr-90 discharged to this trench, the discussion will be concerned with its movement.

Strontium Movement in the Soil

There are numerous factors which influence the movement of strontium in the soil (1): a) the surplus of water in the soil, its rate and direction of movement; b) the cation-exchange capacity and nature of the minerals in the soil; c) the presence of materials in the soil which form relatively insoluble compounds with strontium; d) the mass of material through which the strontium solution must percolate before reaching the water table; e) the chemical composition of the percolating water, including pH; f) the occurrence of natural weathering and erosion; and g) the presence of natural flora and fauna with the resulting biological uptake of strontium.

Factors (1) and (d) have been discussed separately by de Laguna, while factors (2, and (5) are of long-term significance only and would not have had a discernible influence on the six weeks operation of Waste Isolation No. 6. The remaining factors deal with either the nature of the percolating water or the nature of the percolating solution and thus affect the mechanisms of the strontium retention.

Mechanisms of Strontium Retention

Chemically, strontium behaves much like calcium. Unpublished data from a series of experiments involving calcium-strontium exchange on a number of clay minerals show that there is practically no selectivity for the sorption of strontium over calcium, even in the range of trace concentrations of strontium. The selectivity factor, the ratio of Sr/Ca on the mineral to Sr/Ca in solution, varied from 0.8 to 1.8 for various clay minerals. Because of valence effects, however, strontium is more strongly held by ion exchange materials than sodium.

Clay minerals subjected to highly basic solutions may become "hydroxylated" (2). The additional exchange sites generated by hydroxylation are more selective for strontium in comparison to sodium than the original exchange sites arising from isomorphic substitutions within the clay mineral lattice. Although a one to one exchange of calcium and strontium would likely prevail.

From this it would be expected that in a natural soil system, in which sodium is the predominant exchangeable cation, strontium would move rather readily if ion exchange were the only retention mechanism.

Because strontium behaves nearly like calcium, it is often possible to effect strontium removal from a waste stream by co-precipitation with a soluble calcium salt. In the treatment of ORNL process wastes the strontium is precipitated as CaCO_3 which scavenges the strontium even though the

1. H. Jacoby, "Strontium Movement in the Soil," Nuclear Safety 2, 2, 1960, 1960.

2. K. Morgan, "Waste-Sorbent Interactions for Strontium Removal," Presented at the Health Physics Society Annual Meeting, June 15-16, 1961, Las Vegas, Nev.

October 30, 1961

in a soil system would be retarded because its hydrolysis would provide a continuous supply of OH^- ions to compete with strontium for the exchange sites. Tamura (2) has shown that in a natural magnesium-vermiculite system the addition of phosphate to the influent solution caused a reduction in strontium sorption. Still in a natural magnesium-vermiculite system the addition of phosphate was beneficial. In the latter case the phosphate was not sufficient to prevent the exchangeable magnesium removing it from competition for the exchange sites. In the former case the strontium tended to associate with the soil phosphate preferring to remain in solution with it rather than sorb onto the vermiculite exchange sites.

In ion exchange systems the influences of phosphate additions are rather complicated. Tamura (2) has shown that in a sodium-vermiculite system of pH 9 the addition of phosphate to the influent solution caused a reduction in strontium sorption. Still in a natural magnesium-vermiculite system the addition of phosphate was beneficial. In the latter case the phosphate was not sufficient to prevent the exchangeable magnesium removing it from competition for the exchange sites. In the former case the strontium tended to associate with the soil phosphate preferring to remain in solution with it rather than sorb onto the vermiculite exchange sites.

Although it is not yet possible to quantify all of the calcium-strontium-phosphate interactions, some general recommendations can be made. The desirable characteristics for disposal of intermediate-level liquid wastes to surface seepage pits are:

- 1) Minimum concentration of calcium.
- 2) Highly basic conditions.
- 3) Sodium saturation of exchange sites.
- 4) Adequate solution retention time for exchange reactions to proceed.
- 5) Intensive contact between solution and adsorbent.

Measurements Near Trench No. 6 and Their Postulated Influence on Strontium Sorption

Samples were obtained of the waste effluent being discharged to the intermediate-level waste pits and trenches on October 16. Liquid samples were withdrawn from Trench No. 6, from wells 5, 6, and 7 in the Trench No. 6, and from the seep resulting from the operation of Trench No. 6. In addition samples of shale were taken at the seep and from other locations in the general area. The pH of these samples were measured, using a glass electrode and a pH meter. When the pH read greater than 9 titration with 0.1 M HCl to pH 7 gave a corrected value for hydroxyl ion concentration (Table III). Even in the very short distance to the observation wells the pH of the seep solution had been reduced to nearly neutral. The pH of the seep solution was quite close to the pH of well weathered soil formed from the shale in this area.

In near neutral ranges of pH the strontium would be expected to sorb very rapidly in the Conasauga shale. Tamura (2) states,

Table III. Determination of Sr-90 Activity of Samples of Solution Obtained from the Vicinity of Waste Trench No. 6.

Location	Acid Required to Reach pH = 7 (cc/liter)	pH	Sr Activity µc/ml
High water after tank fill (distilled solution)	3.04	10.0	0.230*
Well No. 5	0.039	9.9	N.D.
Well No. 6		7.3	6.08×10^{-5}
Well No. 7		7.4	7.88×10^{-5}
Seep		7.1	1.10×10^{-4}
		4.9	3.29×10^{-4}

*Average of six weeks operation.

"It is particularly important to remember the influence of pH on the sorption of strontium since many radioactive waste-disposal operations are carried out under basic conditions. If a portion of the strontium is retained on the surface by adsorption type ion-exchange reactions as with vermiculite, a decrease in pH will cause leaching to occur. Thus, even distilled water with a pH of 7 will leach strontium if sorption has occurred at a higher pH."

Although the strontium activity of seep solution is higher than the activity in wells 5, 6, or 7, the strontium activity of these observation wells is still greater than has been observed previously in ground disposal operations. If the geology of the site had not been so unfavorable as to result in a seep of activity to the surface, the unfavorable chemistry of the seep indicates that Trench No. 6 would not have operated satisfactorily.

Conclusions and Recommendations

There are a number of factors contributing to the rapid movement of strontium from Waste Trench No. 6:

- 1) It is a high calcium system.

The lower concentrations of sodium discharged to the waste trench are ineffective in replacing the native calcium from the Cona Laga shale.

In addition, the limestone in the trench is subject to continued hydrolysis and provides a large supply of calcium for replenishment of calcium on the adsorption sites.

- 2) It has a minimal hydroxyl concentration.

The trench has not yet received sufficient caustic (NaOH) to raise the soil pH to a point sufficient to precipitate calcium and strontium salts. Soil has a rather high capacity to buffer pH and this may be satisfied by continued application of caustic.

- 3) There is rapid percolation and solution resulting in maximum contact between the solution and the sorbent. This is the factor that accounts for the higher activity in the seep in the closer observation wells.

In comparing the operation of Waste Trench No. 6 with that of Waste Pits No. 2, 3, and 4 the major differences in chemistry would seem to be that Waste Pits No. 2, 3, and 4 have been operated at high pH in a sodium buffer system. This has resulted from long-term discharge of wastes having higher concentrations of sodium salts and of caustic than the wastes currently being discharged to Waste Trench No. 6. Waste Trench No. 6, on the other hand, is now operating in a sodium system at rather low pH. The significance of these conditions on strontium sorption are readily apparent from the preceding discussions.

It would be difficult to recommend any corrective action for Waste Trench No. 6, in view of the rapid seep. In regard to improving the chemistry of the system, it has been suggested that caustic be added to the trench to raise the soil basicity. In future trenches (if they are to be built) pretreatment of the limestone filler with phosphate should prevent sorption of strontium on the limestone bed, though it would probably be more effective to use rock phosphate as the trench filler material.

In view of the extreme hazard associated with the movement of Sr-90 it is further suggested that any remedial action for Sr-106 retention be delayed for its effect on Sr behavior.

Treatment of Trench 6

Although it was not discussed at the Waste Effluent Committee meeting, it develops that Waste Trench No. 6 was subjected to pretreatment for "improved" removal of strontium and ruthenium from the waste streams. The trench was filled with limestone (CaCO_3) and was followed by a treatment consisting of the addition of 10 T, $\text{CuSO}_4 \cdot 5 \text{H}_2\text{O}$ in 20-30,000 gal water. The trench was filled with water and allowed to seep to dryness.

October 30, 1961

3.7 M. NaOH was then added in 35-40,000 gal waste. Na_3PO_4 is added to the waste stream at a rate of 100-150 ppm and the pH of the waste is brought to pH > 11 as shown by pH indicator paper.

It also developed that the sodium ion concentration of the intermediate waste stream is now much lower than the average concentration discharged to pits 2, 3, and 4. Thus it seems that in French No. 5 there is a combination of conditions contributing to the problem of French 4.

Since the map shows the greatest activity, indicating the favorable geology of the site of French No. 6, it is also noted that French Nos. 6 and 7 contain substantial concentrations of strontium. This indicates the unfavorable chemistry of the system and indicates that French No. 6 would not have operated satisfactorily even if the geology had been satisfactory.

Recommendation

This incident, as have a number of other incidents in the past, points to a weakness in ORNL's set-up for radioactive waste management, particularly as it affects solid waste burial grounds and liquid waste pits or trenches. On the one hand, Operations Division has the responsibility to manage disposal operations; on the other, Health Physics Division has the responsibility to monitor the environment. This division of responsibility does not recognize the interest and competence in the Health Physics Division's Radio Research and Engineering Section, the only group in the Laboratory knowledgeable in ground disposal of radioactive wastes.

Much of what we have learned about burial ground and disposal pits or trenches has come from detailed studies of these facilities at ORNL and from the geological conditions that prevail here. Lately, we have attempted to develop an understanding of the geochemical aspects of ground disposal as well. This knowledge and experience has not been put to use in present day disposal operations at ORNL.

I suggest that this be recognized by some formal arrangement between the Operations Division and the Health Physics Division before the location and operating procedure of burial grounds and pits or trenches before construction and operations begin.

W. de Laguna

D. G. Jacobs

Original Signed By:

E. G. Struxness

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

April 3, 1981

To: Distribution

From: C. R. Olsen, I. L. Larsen,
O. M. Sealand, N. H. Cutshall

CRQ

Subject: Review of the Design Criteria and Operational
History of ILW Trench 7

Introduction

From 1951 to 1966, seepage pits and trenches were used for the disposal of intermediate-level liquid wastes (ILW) at Oak Ridge National Laboratory (ORNL). These waste pits and trenches were generally located on ridge tops (Figure 1) and were excavated in the weathered zone of the shales and limestones which comprise the middle formations of the Conasauga Group (Haase and Vaughan, 1981). The weathered zone extends to a depth of 20 to 30 feet (6 to 9 meters). The bedding layers extend east-west, dip south and are highly fractured and folded (de Laguna et al., 1958). The weathered bedrock is broken into small prisms by numerous joints and much of the carbonate has been leached out by the weathering process. The excavated trenches (but not the pits) were backfilled with 9 feet (3 meters) of crushed limestone. Waste liquids (adjusted to a pH of ~ 12 with NaOH) were allowed to percolate through the weathered shale (pH ~ 5) and radionuclide migration was retarded by reactions with the fill and soil.

Pit 1 (the first experimental pit) was opened in 1951 but closed after a single filling because of an immediate breakthrough of radionuclides due to its poor location (Lomenick et al., 1967). Pits 2, 3, and 4 were located on a ridge and operated well; receiving more than 30 million gallons of ILW and $\sim 5 \times 10^5$ curies of activity. During operation of the pits, it was noted that most of the liquid wastes percolated in a direction parallel to the bedding and that very little movement of the liquid was observed across the bedding (de Laguna et al., 1961). Consequently, long-narrow trenches were excavated at right angles to the beds to provide more effective drainage. The trenches, unlike the pits, were covered with fill to reduce the radiation field. Trench 5 (located in Figure 1) began operation in 1960 and received more than 8 million gallons of ILW and $\sim 3 \times 10^5$ curies of activity before being covered with a mound of Conasauga shale and capped with an asphaltic-concrete surface in 1966 (Duguid et al., 1977). Although Trench 5 operated satisfactorily, it could only handle about one-half of the ILW generated by the Laboratory. Trench 6 was brought into operation in 1961 (Figure 1) but received wastes for only a short period because of a radionuclide breakthrough. The breakthrough was thought to have occurred because the water table rose above the bottom of the trench and the resultant shallow-depth ground-water flow was channeled (perhaps through fractures) into a topographic draw just south of the trench (Waste Effluents Committee Rpt., 1961). Although the water table under Trench 5 also rose 10 to 15 feet during its operation, the water table, nevertheless, still remained

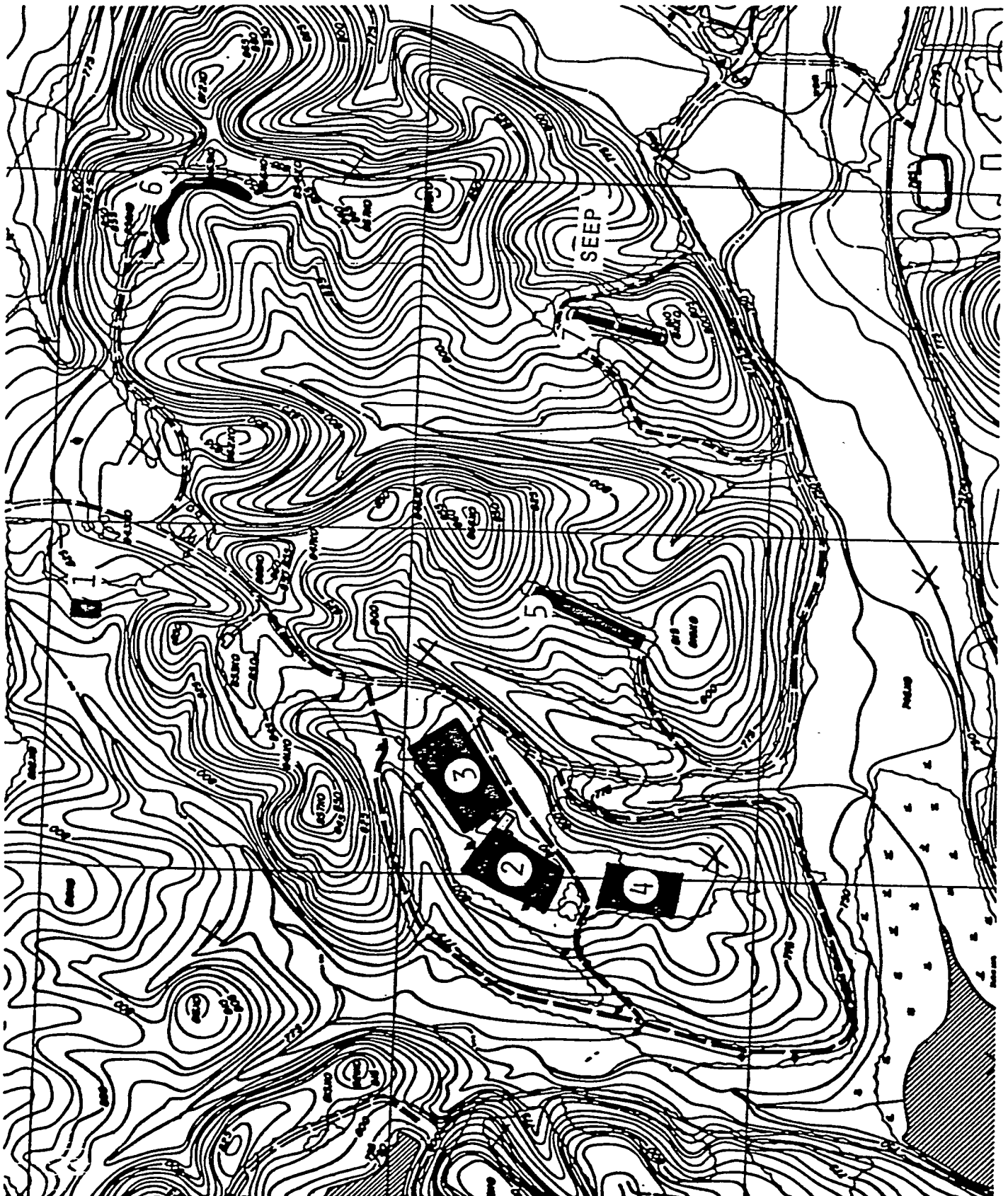


Figure 1
Location of ILW Pits and Trenches at ORNL

well below the level of the trench bottom. With the failure of Trench 6, Trench 7 was excavated in 1962 at a site (Figure 1) which was originally suggested, on the basis of geological considerations (ORNL-LR-Dwg. 63051), for the location of Trench 6. This site was rejected for the location of Trench 6 because of cost estimates for a new pipeline (de Laguna et al., 1961). Geologically, Trench 6 was improperly located, but the geological objections were not known by those making the decision on a cost basis (de Laguna et al., 1961).

Design Criteria ILW Trench 7

A test hole was drilled in the fall of 1961 to measure the ground-water level at the proposed site for Trench 7. The hole was located near, what is now, the northern end of Trench 7B (Figure 2). The water level in this hole occurred at an elevation of 775 feet or ~ 32 feet below the surface on December 4, 1961; a time of the year when one would expect the water table to be at its greatest depth (de Laguna, 1962). On February 26, 1962, the water level in this well rose ~ 14.5 feet to an elevation of ~ 789 feet, which was the proposed level for the trench bottom (Figure 2). de Laguna (1962) pointed out that: 1) the water level could have been higher between readings, 2) it may still go higher during wetter periods and 3) a 10-foot rise in the ambient water level is expected during seepage operations.

Initially, Trench 7 was designed to be a composite of three sections; each 100 feet long, 15 feet deep, 4 feet wide at the bottom and 15 feet wide at the top (Morgan, 1962). This 300 foot trench was to be similar in design to that of Trench 5 (Murray, 1962) with an expected disposal capacity of 3500 gallons per day. The third section (Trench 7C) was omitted because a second test well, drilled in May 1962 about 100 feet to the north of the first well, had a water level elevation of 796 feet which was several feet above the proposed bottom for Trench 7C (de Laguna, 1962). By eliminating segment C, the disposal capacity was expected to be approximately halved, but this reduction was necessary because of the general rise in the ground-water table to the north and its large seasonal fluctuations.

Figure 2 illustrates the design criteria for ILW Trench 7. The figure has been simplified from engineering blueprints (D-52847) which were approved for construction. The trench was backfilled with 9 feet of crushed limestone. Liquid wastes were added to one segment, until it was full, and then added to the second segment, providing time for waste seepage from the first. The liquid wastes were adjusted to a pH of ~ 12 with NaOH to enhance reactions with the fill and precipitate strontium isotopes with calcium carbonates and phosphates. The chemical composition of the intermediate-level liquid wastes discharged to the trenches is presented in Table 1 (Sealand, 1962). Trench 7 received wastes from October 1962 until April 1966, after which deep-well hydrofracture methods were used for the disposal of ILW.

LONGITUDINAL SECTION

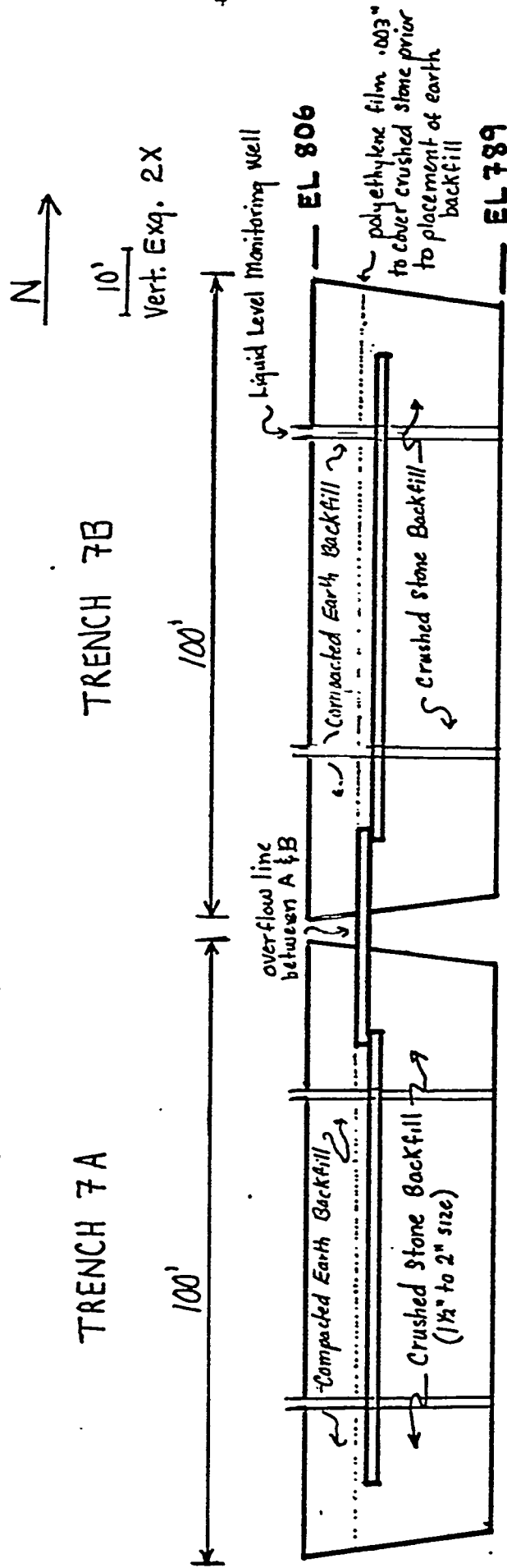


Figure 2. Longitudinal Section of ILW Trench 7 as modified from Engineer Blueprints (D-52847) which were Approved for Construction.

TABLE 1
ANALYSIS OF ORNL INTERMEDIATE-LEVEL WASTE
DISCHARGED TO THE TRENCHES¹

ION	CONCENTRATION	
	(ppm)	(M)
OH ⁻	3600	0.21
NO ₃ ⁻	4760	0.077
HCO ₃ ⁻	<1	<0.000016
CO ₃ ⁼	2600	0.043
SO ₄ ⁼	1280	0.013
NH ₄ ⁺	700	0.04
Na ⁺	4350	0.146
K ⁺	45	0.0012
Ca ⁺⁺	12	0.0003
Mg ⁺⁺	<10	<0.0004
Al	165	0.006
Fe	<0.5	<0.000009
Cu	<3	<0.00005

¹Sealand (Nov. 16, 1962)

Radionuclide Inventory for ILW Trench 7

The monthly quantities of liquid waste and activities of ^{137}Cs , ^{60}Co , total Sr and ^{106}Ru disposed in Trench 7A and Trench 7B are listed in Table 2. These data have been summarized from monthly reports for radioactive waste disposal at ORNL (Lasher, October 1962 to April 1966). In Table 3, the monthly data have been decay-corrected to January 1, 1981, in order to estimate present-year activities.

A summary inventory of radionuclides (including transuranics) disposed in Trench 7 has been presented in Table 4. Data on the amounts and forms of transuranics disposed in Trench 7 were difficult to obtain. Records indicate that ~ 74.4 grams and ~ 76.4 grams of ^{239}Pu were disposed in Trench 7A and Trench 7B, respectively (Duguid et al., 1977). It also appears that ~ 334 grams of ^{233}U may have been disposed in Trench 7. According to Helton (personal communication) 334 grams of ^{233}U in a 10-20% solution left Building 3019 on May 19, 1964 (SNM #6251) to be disposed at ORNL. Although there is no documentation that the ^{233}U was disposed in Trench 7, we have assumed that it was because: (1) it was an intermediate-level liquid waste, (2) it was disposed during the operation period of Trench 7, and (3) ^{233}U concentrations, as high as 200 dpm/l, have been measured in ground water samples collected in the vicinity of Trench 7. The disposal of 62 curies of ^{242}Cm to Trench 7 was noted in the monthly waste disposal report for May 1965:

"Curium-242 was detected this month in the east seep stream from Trench 7 and in the White Oak Dam discharge to Clinch River. Although the amount released was not significant and will not become serious because of the small amount (62 curies) put into that trench, it has become apparent that the trench cannot be used for disposal of large quantities of curium. Arrangements have been made to hold curium-bearing wastes in storage tanks until the waste evaporator is put into operation and trench disposal of waste is discontinued."

It should be noted that ^{242}Cm has a relatively short half-life (~ 162 d), decaying to ^{238}Pu . Thus the ^{238}Pu in the soils near Trench 7 may reflect movement as ^{242}Cm rather than as Pu.

No data on the amounts and forms of other transuranic radionuclides disposed in Trench 7 have been found. Estimates for the disposal of ^{232}U and ^{238}U have been made by assuming that their ratio to ^{233}U was that now measured in ground-water samples near the trench. The trench will be sampled in 1981 to better determine the activity ratios of the various radionuclides and thus estimate, with more certainty, the unknown transuranic inputs.

CRO:ms

TABLE 2

MONTHLY DISPOSAL IN CURIES

TRENCH 7--SECTION A					TRENCH 7--SECTION B						
MONTH YEAR	GALLONS	CS-137	CO-60	SR-90	RU-106	MONTH YEAR	GALLONS	CS-137	CO-60	SR-90	RU-106
10 1962	64700	845	2	20	43	10 1962	64700	874	2	19	42
11 1962	50400	140	1	3	73	11 1962	51600	401	1	13	75
12 1962	97900	603	9	15	242	12 1962	63900	393	6	10	158
1 1963	87000	1554	43	33	31	1 1963	84900	1523	42	32	326
2 1963	54000	2011	23	37	106	2 1963	47400	2346	106	9	36
3 1963	54000	1584	13	13	28	3 1963	47400	1400	20	11	94
4 1963	39000	457	13	13	27	4 1963	97200	1116	32	12	30
5 1963	100900	2941	15	26	17	5 1963	109200	3287	17	162	18
6 1963	109200	1691	37	397	544	6 1963	120900	1780	39	266	18
7 1963	230400	7680	78	182	174	7 1963	125400	3840	39	418	214
8 1963	77600	1264	15	2652	126	8 1963	95600	1555	18	3264	18
9 1963	63800	2770	37	1470	126	9 1963	90400	4155	53	2205	189
10 1963	46800	1160	4	62	23	10 1963	87000	2175	8	116	12
11 1963	95200	899	2	24	25	11 1963	66000	618	2	17	17
12 1963	99600	2285	7	146	28	12 1963	93600	2144	7	137	19
1 1964	147600	3750	7	149	73	1 1964	108000	2500	4	99	19
2 1964	184000	4200	8	24	26	2 1964	88200	2800	6	16	16
3 1964	163000	750	5	93	9	3 1964	112200	500	4	62	1
4 1964	166900	390	10	3900	32	4 1964	85400	260	7	2600	21
5 1964	176600	2823	45	2097	8	5 1964	97600	1882	30	1398	1
6 1964	137200	1245	5	304	13	6 1964	70400	623	23	252	10
7 1964	137200	4400	17	460	13	7 1964	82400	2200	12	230	2
8 1964	169700	6061	22	832	13	8 1964	121600	4389	13	603	2
9 1964	146700	5356	6	1737	13	9 1964	92900	3090	5	1002	2
10 1964	144900	23280	22	6222	13	10 1964	102300	16490	23	440	2
11 1964	81800	1142	2	165	13	11 1964	81500	1142	3	165	2
12 1964	63300	3078	2	88	13	12 1964	69700	3684	3	105	2
1 1965	149600	998	13	793	23	1 1965	105400	730	9	580	2
2 1965	140200	79	9	230	3	2 1965	88200	49	6	144	1
3 1965	184500	3337	30	651	3	3 1965	84900	1778	14	294	1
4 1965	211500	6804	1	900	9	4 1965	81500	2646	1	350	1
5 1965	110400	2248	3	83	16	5 1965	89300	1770	3	66	1
6 1965	87000	700	5	120	2	6 1965	112300	897	6	151	3
7 1965	89400	1137	12	546	2	7 1965	91800	1137	12	546	3
8 1965	53200	2871	19	1341	6	8 1965	125900	7018	24	3270	6
9 1965	49300	3825	13	104	3	9 1965	100600	7225	20	315	3
10 1965	60500	3760	17	185	5	10 1965	109600	6392	6	182	3
11 1965	44900	1526	3	91	1	11 1965	77800	3052	3	1224	3
12 1965	39000	558	1	490	1	12 1965	96000	1394	10	260	1
1 1966	80000	487	10	260	1	1 1966	80000	487	10	1647	1
2 1966	144000	1716	11	2001	0	2 1966	111000	1359	93	1647	1
3 1966	122000	1793	6	517	7	3 1966	111000	1623	5	1647	1
4 1966	14000	580	3	152	1	4 1966	14000	870	4	220	1

MONTHLY DISPOSAL IN CURIES

DECAY CORRECTED TRENCH 7--SECTION A							DECAY CORRECTED TRENCH 7--SECTION B						
CORRECTED TO 1 1981							CORRECTED TO 1 1981						
MONTH	YEAR	GALLONS	CS-137	CO-60	SR-90	RU-106	MONTH	YEAR	GALLONS	CS-137	CO-60	SR-90	RU-106
10	1962	64700	554	0	13	0	10	1962	64700	573	0	12	0
11	1962	50400	92	0	2	0	11	1962	51600	264	0	6	0
12	1962	97900	397	1	10	0	12	1962	63900	259	1	20	0
1	1963	87800	1025	4	21	0	1	1963	84900	1005	4	6	0
2	1963	54000	1329	9	4	0	2	1963	47400	1551	10	20	0
3	1963	54000	1049	2	8	0	3	1963	47400	933	2	6	0
4	1963	39000	303	1	17	0	4	1963	97200	741	3	7	0
5	1963	100000	1953	1	154	0	5	1963	109200	2185	2	40	0
6	1963	109200	1126	4	257	0	6	1963	120000	1186	2	172	0
7	1963	236400	5126	8	118	0	7	1964	125400	2623	4	270	0
8	1963	77600	845	2	118	0	8	1963	95600	1040	4	278	0
9	1963	63800	1856	4	1723	0	9	1963	98400	2784	2	2121	0
10	1963	46900	779	0	957	0	10	1963	87000	1460	6	1436	0
11	1963	95000	605	0	40	0	11	1963	66300	416	1	76	0
12	1963	99600	1540	0	16	0	12	1963	93600	1445	0	11	0
1	1964	147600	2532	1	96	0	1	1964	108000	1688	0	90	0
2	1964	184000	2841	1	98	0	2	1964	88200	1894	0	65	0
3	1964	163000	500	1	16	0	3	1964	112200	339	0	11	0
4	1964	166900	265	1	61	0	4	1964	85400	177	0	41	0
5	1964	176500	1921	5	2576	0	5	1964	97600	1281	1	925	0
6	1964	137200	849	0	1380	0	6	1964	70400	425	3	167	0
7	1964	137200	3005	1	306	0	7	1964	82400	1503	0	153	0
8	1964	169700	4148	2	306	0	8	1964	121600	3004	0	482	0
9	1964	146700	3672	3	554	0	9	1964	92300	2119	1	669	0
10	1964	144900	15993	1	416	0	10	1964	102300	11328	1	294	0
11	1964	81900	786	0	11	0	11	1964	81500	786	0	111	0
12	1964	63300	2117	0	55	0	12	1964	63700	2541	0	71	0
1	1965	149600	690	2	534	0	1	1965	105400	584	1	390	0
2	1965	140200	55	1	155	0	2	1965	88200	34	1	97	0
3	1965	184500	2731	4	440	0	3	1965	84500	1233	1	199	0
4	1965	211500	4729	0	609	0	4	1965	81500	1839	2	237	0
5	1965	110400	1565	0	56	0	5	1965	83300	1232	0	45	0
6	1965	87800	494	1	82	0	6	1965	112300	626	1	103	0
7	1965	89400	795	2	372	0	7	1965	91800	795	2	372	0
8	1965	53200	2011	2	916	0	8	1965	125900	4915	3	2238	0
9	1965	49300	2684	2	71	0	9	1965	100600	5070	3	1356	0
10	1965	60500	2643	2	127	0	10	1965	100600	4494	4	2150	0
11	1965	44900	1075	0	63	0	11	1965	77800	2150	1	125	0
12	1965	39000	394	0	337	0	12	1965	96800	984	0	843	0
1	1966	80000	344	1	179	0	1	1966	80000	344	0	179	0
2	1966	144000	1216	16	1438	0	2	1966	111000	963	13	1138	0
3	1966	122000	1273	1	358	0	3	1966	111000	1152	1	323	0
4	1966	14000	412	0	106	0	4	1966	14000	619	1	150	0
TOTAL							TOTAL						
86							85						
16337							15970						
80330							72498						
CURIES							CURIES						

TABLE 4
 RADIONUCLIDE INVENTORY ILW TRENCH 7¹
 (Total Waste Input: 8.4×10^6 gallons)

Nuclide	Curies (at time of transfer)	Curies (January 1, 1981)
¹³⁷ Cs	223,000	152,830
Total Sr	48,060	32,330 ²
⁶⁰ Co	1,530	170
¹⁰⁶ Ru	3,200	0
²³⁹ Pu	9.2	9.2
²³⁸ Pu	?	>.325 ³
²⁴² Cm	62	0
²⁴⁴ Cm	?	?
²⁴¹ Am	?	?
²³³ U	3.2	3.2
²³² U	(0.38) ⁴	(0.32)
²³⁵ U	?	?
²³⁸ U	(0.11) ⁵	(0.11)

¹Preliminary inventory until Trench 7 is sampled

²Calculated assuming 100% ⁹⁰Sr

³Curies of ²³⁸Pu resulting from the decay of ²⁴²Cm

⁴Calculated using a ²³²U/²³³U ratio of 0.12

⁵Calculated using a ²³⁸U/²³³U ratio of 0.033

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